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Data Sources on U.S. Fish Consumption

Marine Fisheries REVIEW

On the cover: Flounder fillets with lime. See the article on the status of data sources on fish consumption in the United States on page 20.

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National Marine Fisheries Service Habitat Conservation Efforts in the Southeast Region of the United States From 1981 Through 1985

ANDREAS MAGER, Jr., and GORDON W. THAYER

ABSTRACT—The National Marine Fisheries Service (NMFS) is quantifying the cumulative acreage of habitat involved in the Corps of Engineers' (COE) programs relating to water development in the Southeast Region of the United States. From January 1981 through December 1985 the NMFS commented on 23,292 proposals to alter wetlands that had been submitted to the COE. Of these, detailed habitat information was obtained on 5,385 projects involving the potential alteration of 184,187 acres of wetlands. Dredging was proposed for over 80,227 acres and 45,893, 5,846, and 52,222 acres were proposed for filling, draining, and impounding, respectively. NMFS did not object to the alteration of 48,500 acres and recommended the conservation of 135,687 acres. The proposed habitat losses were potentially offset by the 110,406 acres recommended for mitigation. The degree to which our recommendations were incorporated into permits by the COE also was documented. NMFS recommendations were accepted overall 50 percent of the time, partially accepted 24 percent of the time, and rejected 26 percent of the time. Applicant compliance with permit conditions averaged 80 percent. NMFS recomendations on permit applications are made by the Southeast Regional Office and its area offices, but are dependent on up-to-date research information provided by research laboratories of the Southeast Fisheries Center. The close link between these facilities in NMFS fisheries habitat conservation efforts is described.

Introduction

Each year thousands of requests are made to the U.S. Army Corps of Engineers (COE) for permission to alter wetlands. The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) provides recommendations to the COE that are designed to minimize project effects on marine, estuarine, and anadromous fishery resources. Because the amount, type, and geographical distribution of the habitat to be altered are generally unknown, the NMFS Southeast Region began a program in 1980 to compile such information. Another important purpose of the program is to determine the effectiveness of NMFS recommendations. This information not only helps us determine cumulative loss of habitat so the necessary measures can be taken to prevent avoidable damages to fisheries production, but it also allows us to judge the effectiveness of our program so necessary modifications can be made.

Lindall and Thayer (1982) described efforts by the NMFS to quantify the NMFS Southeast Region's involvement in COE programs during the 1981 fiscal year (October 1980-September 1981). They showed that 1,400 permits involving almost 18,000 acres of wetlands were involved. We now have data that quantify efforts for 5 years (1981-85). These data reflect the magnitude of the potential wetland alterations, the acreage actually permitted for alteration, and the acreage potentially mitigated.

Since mitigation is becoming a major part of NMFS efforts to conserve fisheries habitat, NMFS Southeast Fisheries Center (SEFC) efforts in evaluating the effectiveness of mitigation recommendations are described. Mitigation seeks to reduce or eliminate adverse impacts, and NMFS only recommends mitigation to compensate for unavoidable loss of resources due to human activities when all realistic alternatives to avoid impacts have been evaluated (Thayer et al., In press; Ashe, 1982). Unfortunately the process of mitigation is generally untested, and we do not know if mitigated habitats support the production of fishery organisms to the extent that unaltered natural systems do. This information is vital in view of the increasing use of mitigation to compensate for habitat loss and is invaluable to the evaluation of project effects.

The information we provide covers only the wetlands in the NMFS Southeast Region (North Carolina to Florida to Texas plus Puerto Rico and the U.S. Virgin Islands) upon which marine, estuarine, and anadromous fishery resources managed by the NMFS depend. Other wetland conservation programs exist for which we have no data. For example, each state in the Southeast Region has wetland conservation programs for resources under its purview. The same holds for other programs such as those pursued by the U.S. Fish and Wildlife Service (FWS) and the Environmental Protection Agency (EPA).

Background

The NMFS Southeast Regional Office and the SEFC are responsible for the

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protection, management, and development of marine fisheries from North Carolina to Florida to Texas, including Puerto Rico and the U.S. Virgin Islands. In the Southeast Region at least 96 percent of commercial fishery landings and over 70 percent of the amount of recreational fish caught consist of species that inhabit estuaries at some point in their life cycle.

The commercial yield of these species (including Alaska, but excluding Puerto Rico and the U.S. Virgin Islands) for 1981 through 1985 was about 46 percent of the total U.S. landings (NMFS, 1983; 1985; 1986). This amounted to about 13.6 billion pounds of fish and shellfish worth at least $3.8 billion at dockside in the Southeast Region. Marine recreational yield in the southeast for 1981 through 1985 was about 56 percent of the total recreational landings in the United States. This amounted to about 1 billion fish taken by recreational fishermen from North Carolina to Texas (NMFS, 1985; 1986).

This coastal area is experiencing rapid changes in land use patterns. These changes are associated with human population growth, and are leading to physical loss of vital fishery habitat, closure of fish and shellfish areas due to contamination, fish mortality due to hypoxia, and diseases that are linked to poor water quality. The most significant environmental alterations related to fishery losses are physical modification of habitat, addition of biological and chemical pollutants, and alteration of freshwater inflow patterns (Lindall et al., 1979; Tiner, 1984).

Effective management of fisheries for the nation's benefit relies largely on maintaining and enhancing critical habitat. The importance of estuarine habitat to commercial and recreational marine fisheries in the southeast is documented in Douglas and Stroud (1971), Thayer et al. (1975, 1979), Turner (1977), Peters et al. (1979) and Thayer and Ustach (1981). Alexander et al. (1986) estimated the remaining saltmarsh, fresh marsh, tidal flats, and swamp wetlands in the Southeast Region at only about 9.4 million acres, representing about 83 percent of the 11.3 million acres of remaining wetlands of these types in the contiguous United States. Within these general wetland categories, some specific habitat types may be actually increasing in extent in some areas while others are disappearing at an unprecedented rate. Thus, it is important not only to obtain information on major wetland habitat types (e.g., Alexander et al., 1986), but also the acreage and distribution of specific wetland habitat types (e.g., Tiner, 1977; 1985).

Wetland losses occur continuously from natural causes, although currently there is no way to quantify them adequately. Erosion, subsidence, marsh deterioration, and rising sea levels are but a few of the natural forces that alter wetlands. In Louisiana, for example, natural and human-induced forces contribute to a yearly land loss, including marsh, of more than 32,000 acres or 50 square miles (Gagliano, 1984). In view of these continuing wetland losses, the need to closely monitor and minimize the effects of avoidable losses, such as those affected by state and federal regulatory wetlands programs, is even more vital. This is the primary reason NMFS monitors activities that potentially alter wetlands.

NMFS Southeast Region habitat conservation activities are carried out by 13 fishery biologists in the Habitat Conservation Division (HCD) located in four offices: Beaufort, NC; St. Petersburg, Fla.; Panama City, Fla.; and Galveston, Tex. Lindall and Thayer (1982) provide greater detail on operation of these offices. A fifth office is planned for Baton Rouge, La., in 1986. Each year these biologists review 4,700-6,000 permit applications. Added to this workload are other federal, state, and local projects, preapplication meetings, review of environmental planning documents, meetings to resolve conflicts with permit applications, and a host of related activities. Because of the tremendous workload and size of the area covered, the HCD relies on SEFC research expertise to obtain up-to-date information upon which to base its recommendations. This is necessary to ensure that recommendations are valid and defensible. The Fishery Habitat Program of the SEFC is located at the Beaufort and Galveston Laboratories. Research information needs of the HCD are incorporated into ongoing research projects, which include larval fish ecology, use of wetland habitats by fishery organisms, development of habitat evaluation techniques, evaluation of mitigated habitats, and effects of contaminants (primarily heavy metals), and habitat losses on ecologically and economically important species.

The NMFS recognizes that conservation of nearshore and marine fishery habitats is fundamental to any attempt to rationally manage fisheries, and mitigation is considered if there are no alternatives to projects that are water dependent, needed for national defense, or high in public interest. Projects considered in the public interest by the COE continue to cause alteration and loss of wetland habitat, particularly when their cumulative impacts are considered (Thayer et al., In press). Mitigation recommendations are made to lessen the impact of development to fishery habitats. In making mitigation recommendations, NMFS attempts to reestablish wetland fishery habitats and their ecological functions. Although techniques do exist to revegetate salt marsh, mangroves, and seagrass meadows (see Thayer et al., In press), there is little evidence that these habitats are capable of supporting or sustaining the production of fishery organisms as do their natural counterparts. Accordingly, the SEFC Fishery Habitat Program at Beaufort and Galveston has initiated research efforts to evaluate the use of mitigated habitats by fishery organisms.

In a review of mitigation in the Southeast Region, Thayer et al. (In press) noted that mitigation can take several forms: Preapplication, habitat creation, restoration and enhancement, and mitigation banking. NMFS seeks alternative sites for projects, less-damaging construction methods, etc., in seeking to lessen or avoid impact in preapplication meetings and during review of public notices that advertise projects. One of the major wetland mitigation tools used by NMFS is recommending restoration or generation of habitat to replace wetlands that have been altered illegally or are proposed to be altered for activities such as water-dependent projects (Lin-

dall et al., 1979; Thayer et al., 1985; In press). This technique has been readily accepted as evidenced by the large amount of habitat recommended by NMFS and approved by the COE for restoration and generation. The NMFS in making mitigation recommendations, attempts to have in-kind mitigation or habitat replacement conducted adjacent to the area of habitat loss or in the same aquatic system. We continue to stress, however, that mitigation is still an experimental technique that has not been adequately evaluated.

A cooperative agreement between NOAA and the U.S. Department of the Army (Civil Works) was signed in October 1985 for a series of pilot studies to evaluate the feasibility of establishing a national program for restoring and creating fishery habitat. The agreement is intended to merge the NMFS interest in the nation's fisheries productivity and the COE's water resources development program, engineering expertise, and experience. The NMFS Southeast Region was selected as one of the pilot study areas. Currently, sites are being selected where wetlands can be created or enhanced to restore fisheries habitats which were degraded or destroyed in the past. The COE will be responsible for designing or modifying sites appropriate to the fishery habitat creation or enhancement needs, and NMFS will be responsible for evaluating the viability of these areas for fishery organisms.

A computerized system to track permit recommendations and proposed habitat alterations involved in COE programs in the southeast began in late 1980 and was preliminarily reported in Lindall and Thayer (1982). The system has been developed and five years of data are now available. NMFS tracks individual actions by the amount of potential impact (i.e., dredge, fill, drain, impound); the amount of habitat modification NMFS accepts or does not object to; the amount of habitat potentially conserved; and the amount of habitat modification actually permitted by the COE. The latter data track only those permits where we are notified of issuance by the COE and we have historical data to judge what habitat alterations were originally proposed.

Data can be retrieved by project location, habitat type, timeframe, impact, and whether restoration or generation of habitat was involved. Data also can be retrieved by the kind of activity involved (e.g., permit application, unauthorized activity, federal project); the type of project (e.g., navigation, oil and gas, housing development, beach restoration, mineral mining, barriers, and impoundments); and whether NMFS objected to, recommended modifications, or approved the activity. The results of the first 5 years of quantification of NMFS efforts are summarized in the next section.

The acreage values associated with permit actions reflect projected losses due to direct removal, burial, impounding, and draining. Frequently, particularly in the case of seagrass habitats, additional habitat loss can be incurred that the project-specific permitting process does not address. There are few areas in the Southeast Region where recent accurate maps of seagrass distribution have been completed. Where maps do exist, declines in seagrass species frequently have been reported (e.g., Tampa Bay, Fla.). The magnitude of the losses that have occurred or are projected to occur through the permitting process are highly conservative. This is due to the fact that seagrasses and other submerged aquatic plants are dependent on good water quality, specifically low water turbidity, to survive. Increased turbidity, which often is the result of nonpoint source pollution and related discharge problems, are not addressed by the permit process or in our data.

Results

From 1 January 1981 to 31 December 1985 the NMFS responded to 23,292 permit actions from the COE for review and comment. These actions included the following types and number of construction activities: Bulkheads, ramps, groins, and other shoreline activities (8,599); oil and gas exploration and development projects (4,938); navigation channels and marinas (2,943); unauthorized construction in wetlands (1,572); unclassified (1,553); pipelines (1,289); bridges and highways (632); housing developments (475); industrial developments (374); barriers, dams, and impoundments (292); transmission lines (248); irrigation projects (193); mining activities (80); electric generating facilities (53); and beach restoration projects (51). Of these, 17,165 (74 percent) were given a "no objection" response because our analysis showed that adverse impacts would be minimal or damage could be restored or mitigated through appropriate construction techniques. In-depth analyses were conducted on 5,596 actions (24 percent) because it appeared that adverse effects to fishery resources could occur if the project were conducted. The remaining 531 proposals (2 percent) were not assessed because of insufficient staff and funds or because the public notice stated that the COE would only consider recommendations pertaining to navigation and national security. The latter cases involved COE permits for placing oil rigs in offshore waters.

NMFS habitat conservation efforts are summarized in Table 1 by state, the number of permit applications reviewed, and the acreage of habitat involved in dredging, filling, draining, and impounding. Summaries are given in Table 2 by year, and a listing by habitat type proposed for alteration, allowed or not objected to by NMFS, potentially conserved, and mitigated is provided in Table 3. Region-wide quantification of these data is briefly described below.

Dredging

During the 1981-85 period (Table 1, column 2), 80,227 acres were proposed for dredging. Of this total, 88 percent was in Louisiana, 4 percent in Texas, 3 percent in Florida, 1 percent in North Carolina, and 4 percent in the remaining states, Puerto Rico, and the U.S. Virgin Islands. The NMFS did not object to dredging 30,139 acres (Table 1, column 6), but recommended against dredging in 50,088 acres (Table 1, column 10). Most of the proposed dredging was for navigation, especially by the oil and gas industry in Louisiana to gain access to well sites.

Unvegetated substrates (Table 3) proposed to be dredged comprised 76,503 acres (95.4 percent) of the 80,227 acres

Table 1.—Number of proposed projects and acres of habitat by state involved in NMFS habitat conservation efforts from 1981 through 1985. Numbers in parentheses refer to columns discussed in text.

State	No. of permit applications (1)	Acreage proposed by applicants				Acreage NMFS accepted or did not object to				Potential acreage conserved				Mitigation recommended by NMFS	
		Dredge (2)	Fill (3)	Drain (4)	Impound (5)	Dredge (6)	Fill (7)	Drain (8)	Impound (9)	Dredge (10)	Fill (11)	Drain (12)	Impound (13)	Restore acreage (14)	Generate acreage (15)
LA	1,229	70,657.3	36,513.5	5,139.9	37,563.8	24,558.2	7,939.3	160.5	6,274.3	46,099.1	28,574.2	4,979.4	31,289.5	92,471.8	10,914.3
TX	684	3,541.9	3,916.3	0.1	9,186.0	2,017.8	688.9	0	987.4	1,524.1	3,227.4	0.1	8,198.6	3,904.8	557.2
MS	94	120.3	386.6	5.0	6.3	61.4	245.7	0	0	58.9	140.9	5.0	6.3	6.2	37.4
AL	206	423.5	533.9	0	1.9	226.6	53.0	0	0	196.9	480.9	0	1.9	40.1	7.1
FL	1,806	2,733.1	2,870.8	0.5	275.1	1,914.3	926.1	0.2	5.8	818.8	1,944.7	0.3	269.3	475.4	765.1
GA	194	625.6	411.5	0	69.2	94.4	109.9	0	0.2	531.2	301.6	0	69.0	34.1	213.0
SC	576	844.5	419.3	0	4,345.9	333.6	103.4	0	12.5	510.9	315.9	0	4,333.4	68.0	41.1
NC	547	1,133.6	612.0	700.0	673.9	869.0	435.1	300.0	68.4	264.6	176.9	400.0	605.5	491.4	85.0
PR	42	66.7	180.2	0	100.0	18.1	15.3	0	0	48.6	164.9	0	100.0	147.7	11.5
VI	7	80.4	48.7	0	0	45.4	35.5	0	0	35.0	13.2	0	0	0	134.5
Total	5,385	80,226.9	45,892.8	5,845.5	52,222.1	30,138.8	10,552.2	460.7	7,348.6	50,088.1	35,340.6	5,384.8	44,873.5	97,639.5	12,766.2

Table 2.—State and yearly totals for acres of habitat involved in NMFS habitat conservation efforts from 1981 through 1985.

State	1981	1982	1983	1984	1985	Total
Acreage proposed for dredging, filling, draining and impounding						
Louisiana	3,565.4	73,753.1	12,398.3	4,415.8	55,742.3	149,874.9
Texas	1,253.8	2,801.3	5,444.3	2,076.6	5,068.3	16,644.3
Mississippi	37.8	54.0	84.7	48.4	293.1	518.0
Alabama	80.2	419.3	85.5	322.6	51.8	959.4
Florida	1,159.8	1,082.9	1,056.7	840.3	1,739.7	5,879.4
Georgia	266.0	280.5	84.8	34.6	440.4	1,106.3
South Carolina	1,027.5	2,670.8	1,070.6	196.7	644.0	5,609.6
North Carolina	490.3	75.9	460.2	541.5	1,551.5	3,119.4
Puerto Rico	67.8	46.4	16.9	104.6	111.1	346.8
Virgin Islands			75.9	25.3	28.0	129.2
Total	7,948.6	81,184.2	20,777.9	8,606.4	65,670.2	184,187.3
Acreage NMFS allowed or did not object to						
Louisiana	1,897.1	20,818.2	7,352.4	3,015.3	5,849.0	38,932.0
Texas	96.4	351.5	484.1	258.8	2,503.5	3,694.3
Mississippi	26.8	3.9	10.2	15.9	250.2	307.0
Alabama	19.3	173.1	24.8	46.5	16.0	279.7
Florida	392.2	325.0	471.4	487.1	1,170.8	2,846.5
Georgia	26.9	32.9	78.8	25.8	40.0	204.4
South Carolina	35.9	72.5	113.8	50.4	176.9	449.5
North Carolina	369.1	43.5	55.8	77.8	1,126.4	1,672.6
Puerto Rico	4.5	10.5	13.9	3.6	0.9	33.4
Virgin Islands			53.0	0	27.9	80.9
Total	2,868.2	21,831.1	8,658.2	3,981.2	11,161.6	48,500.3
Potential acreage conserved						
Louisiana	1,668.2	52,934.8	5,045.7	1,400.4	49,893.2	110,942.3
Texas	1,157.5	2,449.8	4,960.2	1,817.8	2,564.8	12,950.1
Mississippi	11.1	50.1	74.5	32.5	42.9	211.1
Alabama	60.9	246.3	60.7	276.1	35.8	679.8
Florida	767.6	757.9	585.4	353.2	569.0	3,033.1
Georgia	239.1	247.6	6.0	8.7	400.4	901.8
South Carolina	991.6	2,598.3	956.8	146.3	467.1	5,160.1
North Carolina	121.3	32.4	404.4	463.7	425.1	1,446.9
Puerto Rico	63.3	36.0	3.0	101.0	110.2	313.5
Virgin Islands			22.9	25.3	0.1	48.3
Total	5,080.6	59,353.2	12,119.6	4,625.0	54,508.6	135,687.0
Restore/generate acreage recommended or approved						
Louisiana	1,212.6	7,513.2	26,027.9	53,083.6	15,548.8	103,386.1
Texas	1,032.8	117.0	127.1	99.0	3,086.1	4,462.0
Mississippi	17.5	2.8	1.8	2.2	19.3	43.6
Alabama	6.3	29.8	0.5	9.8	0.8	47.2
Florida	97.6	160.0	346.8	336.6	299.5	1,240.5
Georgia	5.5	57.0	119.7	16.0	48.9	247.1
South Carolina	19.7	21.4	9.1	22.4	36.5	109.1
North Carolina	43.0	6.8	14.4	480.3	31.9	576.4
Puerto Rico	36.1	1.9	12.7	0	108.5	159.2
Virgin Islands			115.0	0	19.5	134.5
Total	2,471.1	7,909.9	26,775.0	54,049.9	19,199.8	110,405.7
No. of permit applications	811	1,059	825	888	1,802	5,385

of habitat to be dredged, while vegetated wetlands totaled 3,724 acres (4.6 percent). NMFS did not object to dredging in 28,683 acres of unvegetated substrates (95.2 percent of the total for Table 1, column 6) and did not object to dredging in 1,456 acres of vegetated wetlands (4.8 percent). Vegetated wetlands potentially saved from dredging totaled 2,268 acres (4.5 percent of the total for Table 1, column 10) while unvegetated substrates totaled 47,820 (95.5 percent).

Filling

Filling of 45,893 acres (Table 1, column 3) was proposed: 79.6 percent in Louisiana; 8.5 percent in Texas; 6.2 percent in Florida; and 5.6 percent in the remaining states, Puerto Rico, and the U.S. Virgin Islands. The NMFS did not object to filling on 10,552 acres (Table 1, column 7): 75.2 percent of the filling which NMFS did not object to was in Louisiana; 8.8 percent in Florida; 6.6 percent in Texas; 4.1 percent in North Carolina; 2.3 percent in Mississippi; and 3 percent distributed in the remaining areas. Most of the filling was for the disposal of dredged material in Louisiana related to oil and gas exploration.

The NMFS recommended against filling on 77 percent of the acreage proposed as follows: Louisiana (80.9 percent); Texas (9.1 percent); Florida (5.5 percent); Alabama (1.4 percent); and the remaining areas (3.1 percent). Vegetated wetlands potentially protected from filling total 8,226 acres (23.3 percent of total for Table 1, column 11), while

Table 3.—Acres of habitat by habitat type involved in NMFS habitat conservation efforts from 1981 through 1985.

	Proposed				Allowed				Conserved					
	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Restore	Generate
Black mangrove	74.3	219.2	0.1	30.6	24.7	68.1	0.1	0	49.6	151.1	0	30.6	56.4	98.4
White mangrove	49.0	253.0	0	45.7	14.9	117.2	0	0	34.1	135.8	0	45.7	27.5	100.2
Red mangrove	60.4	395.4	0.1	205.6	3.6	12.7	0.1	0	56.8	382.7	0	205.6	202.1	359.6
Saltgrass	81.2	304.5	0.4	1,394.7	33.6	71.7	0	0	47.6	232.8	0.4	1,394.7	364.1	1,951.1
Freshwater marsh	740.2	2,405.0	380.0	6,831.9	373.3	1,011.9	0	5,734.0	366.9	1,393.1	380.0	1,097.9	30,783.9	2,013.5
Freshwater unvegetated	170.0	66.8	0	0	169.2	66.9	0	0	0.8	−2.1	0	0	1.5	29.5
Freshwater submerged vegetation	129.6	174.0	12.6	156.4	41.8	90.6	0	0	87.8	83.4	12.6	156.4	102.7	509.4
Hardwood swamp	376.4	1,291.3	887.7	952.0	176.2	381.4	457.0	219.9	200.2	909.9	430.7	732.1	2,557.0	84.1
Black needlerush	212.0	356.0	0.4	1,059.0	21.7	45.9	0	0	190.3	310.1	0.4	1,059.0	98.0	43.1
Other marsh	505.9	2,151.0	309.6	4,513.9	239.2	875.5	0	26.4	266.7	1,275.5	309.6	4,487.5	3,690.4	893.3
Smooth cordgrass	354.9	1,439.7	11.8	3,220.8	105.5	306.7	0	34.1	249.4	1,133.0	11.8	3,186.7	2,344.0	3,883.6
Saltmeadow cordgrass	602.7	2,202.8	4,233.0	7,499.9	279.1	914.9	0	16.5	323.6	1,287.9	4,233.0	7,483.4	36,167.2	1,737.9
Shoalgrass	157.5	34.8	0	0.2	10.0	2.9	0	0	147.5	31.9	0	0.2	15.8	63.8
Halophila	1.5	0.2	0	0	1.5	0.2	0	0	0	0	0	0	0.3	0
Widgeongrass	68.8	148.0	4.1	145.0	40.8	70.6	0	0	28.0	77.4	4.1	145.0	1,031.8	531.7
Manateegrass	8.2	12.0	0	0	3.6	0	0	0	4.6	12.0	0	0	0.8	0.9
Turtlegrass	55.2	28.7	0	1.2	10.9	9.3	0	0	44.3	19.4	0	1.2	1.9	108.7
Eelgrass	1.7	0.2	0	0	1.3	0	0	0	0.4	0.2	0	0	1.4	0.6
Algae	140.8	703.6	0	278.7	20.2	8.0	0	0	120.6	695.6	0	278.7	5.4	4.7
Clay	58.9	3.8	0	0	54.7	0.1	0	0	4.2	3.7	0	0	0	0
Mud	70,808.3	30,979.2	4.3	5,075.7	24,885.1	4,768.4	3.4	504.5	45,923.2	26,210.8	0.9	4,571.2	19,618.5	177.3
Miscellaneous	103.5	360.8	0	19,509.1	53.5	266.9	0	8.3	50.0	93.9	0	19,500.8	13.3	26.4
Oyster beds	13.6	42.3	0	0	0.9	30.0	0	0	12.7	12.3	0	0	0.9	8.6
Rock	155.4	221.7	0	0	3.9	7.9	0	0	151.5	213.8	0	0	0.4	63.9
Sand	4,838.9	1,933.8	1.3	526.6	3,159.3	1,330.5	0	29.8	1,679.6	603.3	1.3	496.8	554.1	74.5
Shell	23.4	77.7	0	0	3.9	2.9	0	0	19.5	74.8	0	0	0.1	1.4
Silt	434.6	87.3	0.1	775.1	406.4	89.0	0.1	775.1	28.2	−1.7	0	0	0	0
Totals	80,226.9	45,892.8	5,845.5	52,222.1	30,138.8	10,552.2	460.7	7,348.6	50,088.1	35,340.6	5,384.8	44,873.5	97,639.5	12,766.2

27,115 acres (76.7 percent) of unvegetated substrates were potentially conserved.

Draining

Nearly all of the 5,845 acres of wetland draining proposals occurred in Louisiana (87.9 percent) and North Carolina (12 percent). The NMFS objected to draining all but 461 acres of wetlands (7.9 percent). Most of the wetlands involved (5,840 acres) were vegetated. *Spartina patens* (saltmeadow cordgrass) comprised 78.6 percent of the wetlands potentially protected from draining. Hardwood swamps comprised 99.2 percent of the wetlands NMFS did not object to be drained. Most of the wetlands were to be drained for agricultural activities, flood control, and mosquito abatement.

Impounding

Regionwide, 52,222 acres were proposed for impounding (Table 1, column 5). Except for the U.S. Virgin Islands, impoundments were proposed in every state and ranged from about 2 acres in Alabama to 37,564 acres in Louisiana (73.8 percent). The NMFS recommended against the impounding of 44,873 acres (85.9 percent of the amount proposed). Of the wetlands proposed for impounding (Table 3), 45,845 acres were vegetated (87.7 percent) and 39,806 acres of potential habitat conserved (88.7 percent) were vegetated. Impounding resulted mainly for flood or water control, agriculture, waterfowl hunting, and mosquito abatement.

Mitigation

To offset the losses of habitat that NMFS accepted or did not object to for activities associated with water-dependent projects which require immediate water use or access to achieve their purpose (Table 1, columns 6, 7, 8, and 9) or from unauthorized construction in wetlands, the NMFS recommends the restoration of disturbed wetland habitats or the generation of new wetlands. Since we do not know if mitigated habitats support the production of fishery organisms to the extent of their natural counterparts, our recommendations for mitigation are made cautiously. From 1981 through 1985, 97,640 acres were recommended for restoration (Table 1, column 14) and 12,766 acres were recommended for generation (Table 1, column 15). Vegetated wetlands comprised 77,451 acres (79.3 percent) of wetlands recommended for restoration and 12,384 acres (97.2 percent) of habitat recommended for generation. Most of the habitat proposed for restoration was in Louisiana (94.7 percent of Table 1, column 14). Most of the generation of new habitat recommended also was in Louisiana (85.5 percent of Table 1, column 15), followed by Florida (6 percent), and Texas (4.4 percent). Using an earlier version of the quantification program, Thayer et al. (In press) estimated that about 4,200 acres of salt marsh (*S.*

Table 4.—Acres of habitat permitted for alteration by the Corps of Engineers from 1981 through 1985.

State	N[1]	Acreage proposed by applicants				Acreage NMFS accepted or did not object to				Acreage COE permitted				Acreage NMFS recommended		Acreage COE permitted	
		Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Restore	Generate	Restore	Generate
LA	120	1,350.3	1,622.9	201.0	6,378.1	1,182.6	1,075.0	0	5,282.0	1,272.5	1,194.5	0	5,445.8	46,305.3	7,381.8	46,102.9	7,352.8
TX	144	812.3	1,669.5	0	4,791.2	435.9	189.1	0	0	529.5	704.8	0	660.3	2,579.9	450.7	2,578.6	475.0
MS	21	37.2	41.1	0	0	4.3	3.9	0	0	19.7	15.4	0	0	1.1	2.2	0.1	35.5
AL	38	34.8	51.1	0	0.2	18.0	6.7	0	0	17.3	15.5	0	0	5.3	6.4	4.6	6.2
FL	264	719.9	1,165.7	0	100.5	333.7	365.1	0	0	550.3	870.3	0	18.7	64.6	267.1	14.8	88.8
GA	26	274.8	79.3	0	69.0	7.2	5.3	0	0	4.9	26.4	0	27.0	28.1	15.9	7.0	8.7
SC	121	79.1	165.6	0	2,134.1	52.9	35.4	0	0	56.6	46.7	0	6.5	13.8	7.1	13.3	11.3
NC	119	67.3	65.2	0	80.6	18.4	21.6	0	20.4	32.8	25.6	0	20.4	4.8	53.9	4.8	53.6
PR	3	51.2	10.7	0	0	1.2	0.7	0	0	51.2	0.7	0	0	0	0.1	0	0
VI	1	0	1.0	0	0	0	1.0	0	0	0	1.0	0	0	0	1.5	0	0
Total	857	3,426.9	4,872.1	201.0	13,553.7	2,054.2	1,703.8	0	5,302.4	2,534.8	2,900.9	0	6,178.7	49,002.9	8,186.7	48,726.1	8,031.9
Grand total			22,053.7				9,060.4				11,614.4				57,189.6		56,758.0

[1]Refers to number of permits sampled.

alterniflora), hardwood swamp, mangrove, and seagrass were recommended to be transplanted in habitat generation projects between June 1981 and September 1984. The analytical process has been refined since that effort, and our present data more accurately reflect actual permit values.

Cumulative Totals

Collectively, 184,187 acres of habitat were proposed for alteration (Table 1, columns 2+3+4+5) throughout the Southeast Region. Over 81 percent occurred in Louisiana. The NMFS did not object to the alteration of 48,500 acres of habitat (Table 1, columns 6+7+8+9) or about 26 percent of the total proposed and, thus, 135,687 acres would be maintained (Table 1, columns 10+11+12+13). To offset permitted or unauthorized habitat losses, 110,406 acres of habitat were recommended for restoration and generation (Table 1, columns 14+15). This acreage is more than twice the area of wetland alterations that NMFS accepted or to which they did not object.

Effect of NMFS Recommendations

The magnitude and impact of these programs on remaining wetlands in the southeast are obvious by tracking the amount of habitat involved in COE programs for an extended period. If all of the NMFS recommendations were accepted by the COE, considerable wetlands of immense importance to commercial and recreational fisheries could be conserved. Therefore, to test the responsiveness of the COE to NMFS recommendations, 857 permit applications were tracked through permit issuance (Table 4). Of the 22,054 acres of habitat proposed for alteration in this survey, the NMFS accepted or did not object to 9,060 acres (41 percent of the acres proposed for alteration). If NMFS recommendations were followed, 12,994 acres of wetland alterations would have been prevented. The COE permitted the alteration of 11,614 acres of wetlands or 2,554 acres more than NMFS recommended to be conserved. The COE approved 56,758 acres of mitigation, 432 acres less than the 57,190 acres recommended by NMFS.

Responsiveness to NMFS recommendations varied by COE district (Table 5). The "NMFS recommendations accepted" column in Table 5 reflects the number of permit applications where all of the NMFS recommendations were incorporated as permit conditions, or if so recommended, the permit was not issued. Partial acceptance was assigned where only part of the NMFS recommendations were included as permit conditions. The "NMFS recommendations partially accepted" column and the "NMFS recommendations rejected" column result in the 2,554 acres of habitat alterations that were permitted by the COE over NMFS objections. Percentage of NMFS recommendations accepted was highest in the Savannah District COE (88.5 percent) followed by the Wilmington District (86.5 percent), the Charleston District (80.2 percent), the Galveston District (55.5 percent), the Mobile District (47.5 percent), and the Jacksonville District (20.1 percent). Percentage of partial acceptance was highest in the New Orleans District (58.3 percent) followed by the Galveston District (31.3 percent), the Mobile District (28.8 percent), the Jacksonville District (20.9 percent), the Wilmington District (7.6 percent), the Charleston District (6.6 percent), and the Savannah District (0 percent). Rejection of NMFS recommendations was the highest by the Jacksonville District (59 percent) followed by the Mobile District (23.7 percent), the Galveston and Charleston Districts (13.2 percent each), the Savan-

Table 5.—Treatment of NMFS recommendations on permit applications by the Corps of Engineers (COE) from 1981 through 1985, by district. Values in parentheses represent percent of N[1] for each category.

COE district	N	NMFS recommendations		
		Accepted	Partially accepted	Rejected
New Orleans	120	47 (39.2%)	70 (58.3%)	3 (2.5%)
Galveston	144	80 (55.5%)	45 (31.3%)	19 (13.2%)
Mobile	59	28 (47.5%)	17 (28.8%)	14 (23.7%)
Jacksonville	268	54 (20.1%)	56 (20.9%)	158 (59.0%)
Savannah	26	23 (88.5%)	0 (0.0%)	3 (11.5%)
Charleston	121	97 (80.2%)	8 (6.6%)	16 (13.2%)
Wilmington	119	103 (86.5%)	9 (7.6%)	7 (5.9%)
Total	857	432 (50.4%)	205 (23.9%)	220 (25.7%)

[1]Refers to the number of permits sampled.

Table 6.—Survey of permits issued by Corps of Engineers (COE) Districts to determine compliance by applicants with permit stipulations, 1981-85.

COE district	Issued permits monitored	Project status		Applicant complied with permit conditions		Percent compliance
		Completed or underway	Not begun	Yes	No	
Galveston	74	44	30	37	7	84.0
New Orleans	118	79	39	68	11	86.1
Mobile	86	69	17	39	30	56.5
Jacksonville	125	107	18	84	23	78.5
Savannah	30	22	8	16	6	72.7
Charleston	62	39	23	35	4	89.7
Wilmington	89	65	24	59	6	90.8
Total	584	425	159	338	87	$\bar{X}$ = 79.5

nah District (11.5 percent), the Wilmington District (5.9 percent), and the New Orleans District (2.5 percent). Region-wide acceptance, partial acceptance, and rejection of NMFS recommendations were 50.4 percent, 23.9 percent, and 25.7 percent, respectively.

Over a 5-year period 584 issued permits were followed to determine applicants compliance with permit conditions (Table 6). Overall, applicants complied with permit stipulations 79.5 percent of the time. Applicant compliance was highest in the Wilmington District (90.8 percent) followed by the Charleston District (89.7 percent), the New Orleans District (86.1 percent), the Galveston District (84 percent), the Jacksonville District (78.5 percent), the Savannah District (72.7 percent), and the Mobile District (56.5 percent). Lindall and Thayer (1982) showed that for FY 1981 compliance with permit conditions was least in the Mobile District and greatest in the Charleston and Savannah Districts.

These data demonstrate the large amount of wetlands involved in COE programs in the Southeast Region. More importantly, the validity of the strong NMFS stand in objecting to unnecessary wetland losses is supported by the potential conservation of at least 135,687 acres of wetlands and the restoration and generation of at least 110,406 acres of additional habitat. Still, these figures are very conservative since the full impact of NMFS involvement in habitat conservation programs cannot be fully quantified. For example, NMFS biologists conduct a large number of preapplication meetings whereby projects are subsequently modified to reduce their impact on wetlands before the application reaches the COE. Many of these projects result in minimal impact on fisheries. Also, NMFS involvement with the COE interagency planning process, in planning for large federal projects, and in other federal, state, and local planning exercises results in benefits to fishery resources. An example of the latter are the more than 260,000 acres of wetlands under management in Louisiana (estimated from permit applications) for which NMFS involvement has resulted in benefits to fishery resources (P. Keney and J. Lyon, NMFS, Galveston, Tex., personal commun.). Moreover, many of the habitat losses tracked may be small in area yet adversely impact larger wetland systems. Examples include fill deposits which alter circulation patterns within estuaries, and barriers which block access to marine fishery resources and alter freshwater inflow needed to maintain optimum salinity gradients and supply nutrients. The strong NMFS opposition to unnecessary wetland losses has been recognized by consultants, large development firms, oil and gas companies, private citizens, and others. This policy undoubtedly results in permit applications that are modified because it is understood that conservation agencies will oppose them or in some cases projects will not even be considered because it is believed that a permit will not likely be granted. The effects of conservation programs by the states, the FWS, and the EPA also are not included in our analysis, but would add considerably to the wetlands affected by regulatory programs. Lastly, we tracked only those projects where we could accurately determine areas of wetlands; therefore, not all acreages involved in COE regulatory programs have been quantified.

Conclusions

NMFS has been only partially effective in getting its conservation recommendations included in approved water-development projects and in achieving compliance. However, the amount of habitat potentially conserved (Table 1) and permitted (Table 4) demonstrates the importance of NOAA/NMFS involvement. Additional emphasis by some COE districts is needed in giving NMFS recommendations more consideration in their public interest determinations and investigating compliance by applicants.

Using one commonly cited estimate of the annual value of an estuary to commercial and recreational fisheries of $100/acre, which is equal to a value of $2,000/acre capitalized at 5 percent (Gosselink et al., 1974, cited in Lindall and Thayer, 1982), habitat conserved by NMFS recommendations could be worth about $271.4 million (135,687 acres × $2,000/acre). Add to this the value of the habitat potentially restored and generated (110,406 acres × $2,000/acre = $220.8 million), the worth at even these conservative values for the 5-year period would be $492.2 million to the commercial and recreational fisheries of the Southeast Region. We recognize the value of an acre of wetlands that we use is open to question and that our acreages of wetlands conserved, restored, and generated are composed of a mixture of wetland types. A range of values per acre could be used. For example, Gosselink et al. (1974) calculated the income capitalized value of an acre of tidal marsh (at only a 5 percent interest rate) to be $82,000/acre

annually for total life support value. This included values related not only to production of commercial and recreational fisheries, but also aquaculture potential and waste treatement. The 5-year worth of wetlands potentially conserved and mitigated by NMFS, using the Gosselink et al. (1974) total life support value, would be increased to almost $20.2 billion. The benefits derived are accrued year after year for the life of the wetlands without human input. Moreover, the value of wetlands increases as the amount remaining decreases and our knowledge of their functions and associated benefits increases. The overall dollar amount is arguable, but illustrates the potential value of our recommendations. When considered with other unquantifiable benefits of the program (see "Impact of NMFS Recommendations" section), the necessary and vital role by NMFS in conserving and managing the habitat needed by commercial and recreational fishery resources is demonstrated.

The cumulative acreage associated with numerous projects is considerable, but yearly amounts of proposed habitat losses are not consistent between years (Table 2). Therefore, such data need to be collected for a long time so a more accurate picture of effects of small water-development projects relative to remaining wetlands can be obtained.

A major emphasis of NMFS recommendations is to provide for restoration or generation of wetlands associated with water-development activities (110,406 acres for 1981-85). The validity of this concept requires in-depth testing. SEFC research here is vital so appropriate recommendations can be made. For example, NMFS may have to become more conservative in recommending mitigation or making adjustments to the type and quantity of habitat recommended for replacement of lost habitat. Research also is needed to determine the quantitative relationship between habitat and fishery resources so that effects of habitat alteration on fish and shellfish production can be predicted. This would enable NMFS biologists to develop their recommendations more specifically to the more than 300 estuarine systems in the Southeast Region. Moreover, recommendations would be more effective and defensible when presented for consideration in COE public interest determinations.

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Inshore Environmental Effects on Brown Shrimp, *Penaeus aztecus*, and White Shrimp, *P. setiferus*, Populations in Coastal Waters, Particularly of Texas

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Introduction

Many states have instituted water management plans that may control freshwater inflow to various coastal bays and marshes, the normal estuarine habitat of species important to marine fisheries. Knowledge of the tolerance ranges and responses of estuarine fauna valuable to sport and commercial fishermen thus becomes increasingly important to advisors, decisionmakers, and scientists. Of this biota, the two commercial species of penaeid shrimp, the brown, *Penaeus aztecus*, and the white, *P. setiferus*, are of prime economic value in the coastal states of the southeastern United States.

Managers of coastal zones, water districts, or fisheries, require a direct avenue to pertinent literature, but biological data upon which to base decisions are scattered. This paper provides a brief overview of the more studied environmental parameters (temperature, salinity, rainfall, and their interactions) associated with ecological factors (location, vegetation, predation, substrate, etc.). Detailed tables and literature citations relate biological responses (growth, migration patterns, seasonal abundance, etc.) of various life stages of penaeid shrimp to particular environmental factors and interactions. Table 1 (brown shrimp), Table 2 (white shrimp), and Figure 1 may be used together to assess the present extent of this information; Figure 1 further identifies those areas and life stages requiring additional research. Each table contains information specific to either *P. aztecus* or *P. setiferus*.

Our discussion compares and contrasts responses of the two species to single factors and their interactions, giving only limited literature citations. Implications for the two species are then explored. The purposes of this paper are to 1) provide, in an easily accessed tabular format, representative information and literature sources relating environmental factors to several inshore life stages of brown and white shrimp and 2) bring attention to those factors, their interactions, and life stages for which information is lacking.

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Materials and Methods

Information described in Tables 1 and 2 was derived both from laboratory studies, primarily upon postlarval and juvenile penaeids, and field observations of all stages including sexually mature adults. The quantity of sources cited in the tables indicate the intensity, relative importance, and ease of measurement (e.g., salinity and temperature), with which factors have been studied.

We have defined postlarvae as those less than 25 mm total length (TL = tip of rostrum to tip of telson), adults as animals which are sexually mature, and juveniles as those less than 100 mm total length, at which size offshore migration of brown shrimp occurs under normal conditions. Data from sources identifying animals only as "juvenile" shrimp without size classification have been included in defining field ranges of that stage.

Discussion

Early studies of the Penaeidae were limited chiefly to white shrimp (Lindner and Cook, 1970), the primary fishery source in most coastal states until the middle 1960's. Efforts were made to understand the causes of declining white shrimp harvest by relating it to environmental factors, primarily salinity, river flow, and rainfall (Gunter, 1950; Gunter and Hildebrand, 1954; Gunter and Edwards, 1969). The apparent decrease in population abundance of white shrimp may have accelerated the research on the brown shrimp, particularly in Texas where brown shrimp constituted the majority of the shrimp fishery (Cook and Lindner, 1970). Emphasis on the latter species continued, both because of its commercial importance and its longer seasonal availability to scientists, resulting in a larger body of data for brown shrimp.

Single Factors

Penaeid shrimp, like other estuarine biota, generally have a wide range of tolerance to many environmental factors commonly measured in inshore waters. *Penaeus setiferus* and *P. aztecus* have been reported in salinities of 1-45‰; *P. aztecus* has been caught in salinities of 60-70‰. In Texas, postlarvae (6-15 mm TL) of both species appear to be limited to a narrower salinity range of 15-35‰. However, most of these

animals have been collected at entrances or inlets to bays during sampling designed to determine the precise date of immigration into the estuary (Baxter, 1963; Baxter and Renfro, 1967; Copeland and Truitt, 1966). Caillouet et al. (1971), in contrast, documented the presence of white and brown postlarvae in Vermilion Bay, Louisiana, in salinities less than 1‰. Postlarvae also survive and grow at controlled salinities as low as 5‰ within a wide range of temperatures, and growth will occur even at lower salinities (Zein-Eldin, 1963; Zein-Eldin and Aldrich, 1965; Zein-Eldin and Griffith, 1969).

Historical evidence (Gunter and Hildebrand, 1954; Copeland and Bechtel, 1974) suggests that young white shrimp occur more frequently and grow faster when nursery areas are of lower (but undefined) salinity. White shrimp juveniles in the laboratory did not die at salinities of 35-40‰ after 30 days continuous exposure, but growth was retarded (Zein-Eldin and Griffith, 1969). Postlarval white shrimp also appear to grow less well, and survival is decreased at salinities of 35‰ compared with 25‰; salinities between 5, 15, 25, and 35‰ have not been examined in detail, nor have juvenile shrimp (>25 mm) been tested in these higher salinities.

Both species occur in a broad temperature range, 5.2-38°C. Survival is reduced at low temperatures, however, and numerous reports document the winter kill of shrimp following cold fronts (Gunter and Hildebrand, 1951; Dahlberg and Smith, 1970; Whitaker, 1983). Laboratory studies have shown that postlarval growth of both species increases with temperature up to 32°C (Zein-Eldin and Griffith, 1969). Brown and white shrimp juveniles occur in water warmed by thermal effluents (Chung and Strawn, 1984), but field data relative to high temperature are generally sparse.

In the laboratory, survival of juveniles (<50 mm TL) exposed to controlled temperatures of 30°C and above varies between species. Small *P. setiferus* continue to grow and survive at constant temperatures approaching 35°C (Zein-Eldin and Griffith, 1969). Survival of juvenile *P. aztecus*, however, decreases with temperatures above 30°C (Zein-Eldin and Griffith, 1969).

Rainfall and river outflow are major phenomena influencing estuarine salinity. Correlations of white shrimp harvests with these factors have been reported for Texas, but do not appear to be valid in some other Gulf states, nor do they apply to catches of the brown shrimp (Hildebrand and Gunter, 1953; Gunter and Hildebrand, 1954; Gunter and Edwards, 1969).

Other individual factors that may be of importance to penaeids during the estuarine phase have been less studied. Requirements for vegetation, substrate type, food, predators, and interactions of these parameters have received little attention. Of these, predation rates have been most discussed (Gunter, 1945; Darnell, 1958; Matlock and Garcia, 1983; Minello and Zimmerman, 1984). Substrate preferences also received early attention (Williams, 1958; Grady, 1971; Rulifson, 1981). Recently, relationships with vegetation and predators have been investigated (Minello and Zimmerman, 1984; Zimmerman and Minello, 1984; Zimmerman et al., 1984). As with studies of substrate, differences in species responses have been demonstrated; only brown shrimp prefer vegetation. Recent studies evaluating various estuarine food sources by carbon isotype techniques (Fry, 1983) supplement earlier assimilation studies and analyses of stomach contents (Condrey et al., 1972; Flint and Rabalais, 1981; Gleason and Zimmerman, 1984).

Interactions

Interactions of salinity with temperature may have more pronounced effects than either factor alone. For both species, the combination of low temperature with low salinity is more detrimental than other combinations (Zein-Eldin and Griffith, 1969). Shrimp are most susceptible to temperatures of 11-15°C at salinities of 5‰ or less, but appear to be somewhat protected against such effects when salinities are nearer to or above those of the open Gulf (25, 35, and 40‰). However, the young of the two species do respond differently to certain temperature and salinity combinations. Survival of postlarval and small juvenile brown shrimp is noticeably reduced by combinations of high temperatures (>30°C) with the salinities ≤5‰. White shrimp at constant warm temperatures are adversely affected by high salinities (35‰ as compared with 25‰; intermediate salinities untested).

Information from factor-interaction studies, in particular of salinity and temperature, has been combined with data from postlarval monitoring to provide annual harvest predictions for brown shrimp. This measurement of the abundance of postlarval brown shrimp (Baxter, 1963) entering the bays and passes was adopted by most states, with various modifications correcting for environmental factors that affect the young brown shrimp in the nursery areas. Thus, Louisiana biologists correct for the number of hours water temperatures are below 20°C (Barrett and Gillespie, 1973; Gaidry and White, 1973). In Mississippi, a more complex formula considers salinity and a salinity-temperature interaction factor, together with a postlarval abundance term based on collections within nursery areas (Christmas and Van Devender, 1981; Sutter and Christmas, 1983).

A somewhat similar formula has been proposed for a limited area of North Carolina (Pamlico Sound: Hunt et al., 1980). Evaluation of white shrimp production based upon a postlarval index has not been attempted, but effects of low temperature on stocks have been described (Whitaker, 1983). Most recently, Garcia (1983) has proposed that an environmental factor be included in stock recruitment analysis of the penaeid fisheries, although few real data are available relating environmental effects to juvenile penaeids of either species (Fig. 1).

Interactions of most other factors are not well documented (Tables 1 and 2). Little is known of the effect of seawater intrusion on the other biota, although changes in species composition during periods of high salinity have been recorded (Parker, 1955; Hoese, 1960). The decrease in abundance and com-

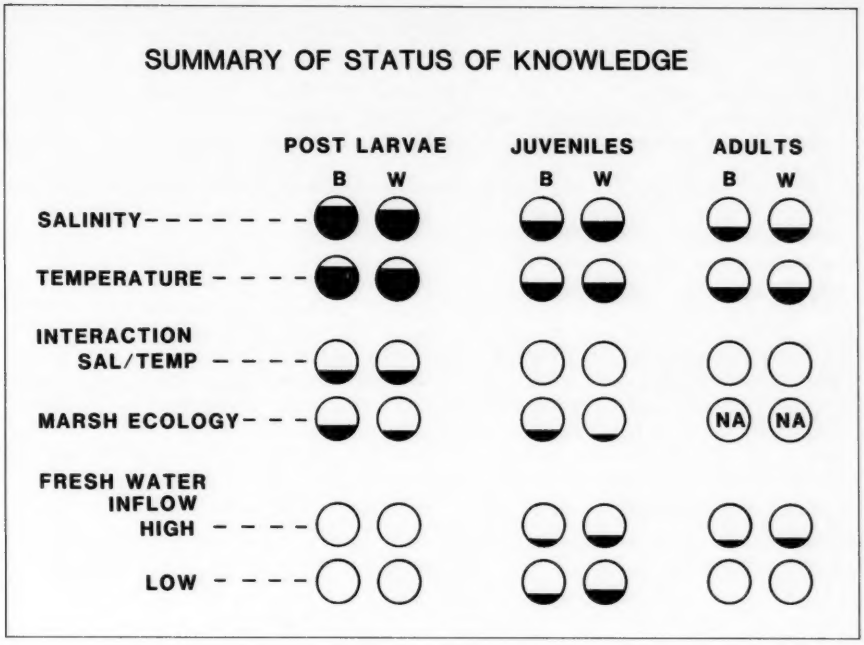

Figure 1.—Summary of the status of knowledge of environmental effects upon life stages of brown shrimp, *Penaeus aztecus* (B), and white shrimp, *P. setiferus* (W). A clear circle indicates no knowledge; a 100 percent black dot indicates complete information. NA = not applicable.

mercial catch recorded during drought (Gunter and Hildebrand, 1954) may indicate more complex ecological or biological relationships, as in the effects of competition and predation by increasing numbers of crabs (Parker, 1955).

In the oyster, laboratory-determined physiological tolerances far exceed the ecological tolerances of the species established by interactions with parasites and predators. Such relationships, as well as those of salinity to vegetation and cover, natural riverine sediments and turbidity, remain to be investigated for penaeids. More detailed ecological examinations might result in a reduction of the broad biological tolerance ranges of these two penaeid species.

Implications

If decisions are made to control estuarine water flow, managers should consider the biological requirements of the penaeids. Based on interaction of only temperature and salinity, without regard to other ecological tolerances, population response would vary with season. Runoff of low salinity waters during colder periods may be detrimental to postlarval browns, as at times of "blue northers" accompanied by heavy spring rains. Young white shrimp occur in nursery areas of lower salinity somewhat later in the spring, however.

Based on the limited data for juvenile shrimp, it would appear that water flow could be restricted during the early spring months, when cold fronts are still likely, to minimize the negative effects of the combination of cold and low salinity on young brown shrimp. Conversely, water inflow would be most necessary during the late spring and summer in the presence of young white shrimp needing salinities below 25‰ and perhaps less, during the warmer months (August-September) of the year. As temperatures decrease in the fall, control of water flow might again be important, since it appears that in postlarvae of both species, survival is better at higher salinities than at 5‰ or less as temperatures decrease to 18°C or less. Penaeids may require variable water flow into nursery areas depending on season, and perhaps on particular year, e.g., early or late entrances of postlarvae into a given system.

Rate of change and length of exposure to the new conditions should also be considered if discharges are designed. Gradual release would be preferred to provide time for the animals to acclimate to the new regime and prevent additional stress from current effects.

Although all of these factors (salin-

ity, temperature, water flow, vegetative cover, food supply, presence of predators and parasites, and concentration of pollutants (heavy metals, etc.)) need to be evaluated for determining the amount of water required for commercial and sport fisheries in the various bays, practicality may demand that only the most stressful factors be included. Thus, consideration must be given not only to 1) the total volume of water to be released, 2) the time of release in relationship to the arrival of young of the year, and also 3) the interaction of temperature and salinity: Maintain higher salinities in cold temperatures, but to simultaneously providing marsh areas with sufficient covering water for the young while lowering salinities (<20-25‰) during hotter summer months when young white shrimp are most numerous in the estuarine areas.

In summary, the biological tolerances to commonly measured environmental factors of both species of penaeid shrimp appear to be broad. The ecological interactions of the animals with other fauna and flora are less well understood, and these latter may play important roles in determining the success of the species in nursery areas and bays, particularly during periods of stress from temperature or salinity.

Ideally, outflows should be planned to minimize stress to penaeid species by carefully monitoring the time of entry of the young shrimp together with the evaluation of actual conditions in the areas of planned waterflow. Temperature records would be important during late February through early April so that effects of low temperature-low salinity interaction upon the brown shrimp population could be reduced. Similarly, estuarine and marsh salinity records during August and September would determine outflow necessary to protect the population of white shrimp.

Table 1.—Inshore environmental effects on brown shrimp, *Penaeus aztecus*.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Temperature	Collection range: 12.6-30.6°C (8-13 mm); burrow from 12-17°C emerge >18°C; 36.6-36.8°C lethal if acclimated at 24°C. Growth rate (30 days) increases between 18 and 27.5°C; decreases at 32°C.	Collection range: 2-38°C; stressed >32°C and <10°C; growth slow <18°C; 10-37°C in ponds if acclimated. Tolerances to extremes: summer 3 h LD_{50} = 38°C; nonsummer 3 h LD_{50} = 36°; optimum catch 20-35°C. Time below 20°C may be important for population survival.	10-37°C in ponds if acclimated.	Total penaeid catch related to net heating days over geographic area; optimum catch 20-38°C; catch range 5-38°C; max. summer resistance at 40°C in 5-14‰ = 103.5 min.; low catch ratio below 15°C, optimum 20-35°C.	2, 3, 8, 9, 12, 13, 14, 18, 20, 22, 23, 24, 25, 26, 55, 59, 64, 65, 71, 72, 75, 81, 83, 95, 114, 127, 128, 134, 138, 140, 142, 143, 144, 147, 148, 150, 151, 152, 154, 155, 156
Salinity	Collection range: 0.10-69.0‰; good growth at 2-40‰.	Range 0-45‰; distributed over entire range; no relation between catch and salinity; burrowing decreased at 34‰ vs. 8.5 or 17‰; prefer 10-20‰?	2-35‰ in ponds; less exposed to salinity variation after emigration.	Collection range 0.5-45.3‰; no preference within estuary.	3, 8, 9, 11, 12, 13, 14, 17, 18, 22, 23, 24, 25, 48, 49, 50, 51, 52, 53, 54, 57, 59, 61, 62, 64, 65, 71, 73, 81, 84, 93, 95, 98, 109, 110, 114, 134, 138, 140, 141, 142, 143, 144, 147, 148, 150, 152, 153, 154, 156
Rainfall		May leave estuaries prematurely if large freshwater inflow occurs.		Catch unrelated to rainfall in Texas or to river discharge in Louisiana.	3, 12, 53, 61, 138, 147
Dissolved O_2		65-86 mm: avoid 1.5 and 2.0 ppm; mean lethal D.O. is 0.8 ppm (1.4 ppm/h reduction) or 0.5 ppm (2.6 ppm/h reduction).	<2.0 ppm = stress. >4.0 ppm = no stress.		11, 13, 80, 85, 94, 97, 114, 118, 121, 122, 142, 157
Substrate	Collected in soft, muddy substrates.	Prefer soft muddy substrates vs. sand or shell; serves as protection from predators.	Prefers sand-silt-clay high inorganic content.		23, 39, 46, 70, 81, 102, 103, 114, 125, 134, 140, 149
Vegetation	Prefer vegetated areas over open areas; use *Spartina* epiphytes for food and stems for cover.	Prefer vegetated areas over open areas; use *Spartina* epiphytes for food and stems for cover; reduced predation observed in *Spartina* vs. open areas.	Do not use vegetation per se; found offshore on sandy-silt-clay bottoms.	Occurs in areas from zero to dense vegetation.	23, 44, 45, 81, 100, 101, 103, 113, 137, 140, 158, 159
Food	*Spartina* epiphytes, *Skeletonema*, and detritus; growth better on animal food than on plant; omnivorous. Larvae: Planktonic feeders.	Omnivorous: Diatoms, detritus, *Spartina* epiphytes, *Artemia*, polychaetes, fecal pellets; progress from encounter feeders to selective feeders; less selective than white shrimp.	Omnivorous: Polychaetes, amphipods, detritus; detrital-based food web is dependent on 80% of primary producer's biomass being directed to bottom in shallow shelf.		21, 23, 32, 45, 70, 72, 113, 140

Table 1.—Brown shrimp data continued.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Predators on Shrimp	Spotted seatrout, crab megalops, southern flounder, pinfish, spot, bighead searobin.	Spotted seatrout, sea catfish, red drum, southern flounder, ladyfish, sea birds, pinfish, Atlantic sharpnose shark, blue crab, Atlantic croaker, black drum, silver perch, sand seatrout.	Spotted seatrout, sea catfish, red drum, southern flounder, ladyfish, croaker, pinfish, Atlantic sharpnose shark, blue crab, sea birds.	Information on predation rates in the field is lacking. Penaeids in stomach contents of predatory fishes are seldom identified to species. Predation on offshore populations may not be a significant source of mortality. Little information is available concerning predation on postlarvae in estuaries, but juveniles are frequently fed upon by fish predators.	4, 23, 28, 29, 30, 33, 47, 58, 68, 74, 78, 84, 96, 99, 100, 101, 102, 107, 108, 111, 129, 130, 133, 135, 140, 159
Growth	Almost none <16°C; rapid (1 mm/day) only >20°C; ≥0.5 mm/day at 26°C; 1.4 mm/day at 32°C; max. growth between 25-27°C; max. growth on *Skeletonema costatum* and *Spartina* epiphyte diet; shrimp in laboratory grow faster when buried for long periods of time (energy conservation).	Lab growth: 12-35 mm/mo. in winter, 24-43 mm/mo. in summer, 50 mm/mo. in spring. Field growth: <0.1 mm/day at <20°C, 1.7 mm/day at 20-25°C, 3.3 mm/day at >25°C. Mark-recapture: 0-0.77 mm/day (males), 0.11-0.89 mm/day (females). Growth decreases at 29-33°C.			12, 23, 25, 38, 42, 43, 45, 63, 66, 68, 70, 71, 79, 83, 93, 112, 124, 127, 128, 138, 140, 141, 142, 143, 145, 147, 153, 154, 155, 156
Migration	Offshore planktonic stages recruit to estuaries from Jan. to June (La.); Feb. to Apr. (Galveston). Positive correlation with wind direction and recruitment (Cedar Bayou); capable of 4.8 cm/sec. salinity independent descent.	Migrate offshore w/new moon Apr. to July (Tex.); June = peak migration time; prefer sides of channels; can descend vertically at about 27 cm/sec. Emigration size approximately 80-100 mm; may be as high as 135 mm; may leave estuaries prematurely if large freshwater inflow occurs.	Remain offshore to grow and spawn. Carbon isotopes in tissues generally converge with that in offshore sediments.		6, 7, 9, 10, 23, 25, 35, 38, 43, 68, 75, 126, 127, 134
Location	Planktonic to demersal; tidal passes to interior marsh.	Range: Secondary streams out to continental shelf; no optimum within range.	Offshore spawning grounds at 25-110 m.		6, 7, 10, 16, 22, 23, 31, 59, 82, 103, 104, 105, 120, 123, 124, 152
Season	Abundant Feb. thru early June; secondary peak Sept.-Oct.	Catch Range: Mar.-Dec.; optimum catch is Mar.-Sept.	Gonads mature in all months offshore; high abundance: May-Sept.; peak abundance: June-Aug.; generally higher catches at night.		6, 7, 9, 10, 12, 16, 23, 24, 39, 63, 75, 82, 105, 114, 120, 123, 124, 134, 158
Prediction	Abundance of postlarvae and juveniles has been used to predict offshore catches of adults with some success.				19, 34, 40, 41, 65
Interactions Salinity-Temperature	24-h survival: 80% at 4-35°C and 5-40 ‰; dependent on acclimation period. 30-day survival: <80% at combinations of approximately 11°C × 12‰, 15°C × 7‰, and 18°C × 2‰. Growth: Increases markedly at 18-20°C; relatively constant in both tissue production and daily growth over salinity range 5-35‰ at any given temperature. Effects of temperature and salinity combinations used in models to predict harvest based on postlarval occurrence indices.	Salinity not important during period of juvenile abundance unless temperatures <20°C; decrease in temperature decreases ability to osmoregulate; oxygen consumption increases with temperature, varies with salinity.		Simultaneous changes in salinity and temperature have more influence on physiological responses than single alteration; most effect at combinations of extremes.	9, 11, 24, 43, 50, 64, 65, 80, 83, 119, 136, 140, 142, 143, 144, 148, 150, 152, 155, 156, 158
Salinity-Location		Present in all estuarine areas regardless of salinity if temperature is tolerable.			24
Salinity-Season		Catch ratio similar at all salinities during seasons of availability.			24, 158
Salinity-Size		Juveniles better osmoregulators than adults; regulate better at salinities >20‰.			11, 64, 150

Table 1.—Brown shrimp data continued.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Salinity-Vegetation		*Spartina* adversely affected by salinity intrusion; intertidal condition necessary for germination.			1, 61, 62, 81, 116, 131, 158
Season-Location			Shallower waters (25 m) during spring and summer; deeper during autumn and winter.		24, 105
Vegetation-Abundance	90% postlarvae in Galveston salt marsh occurred in *Spartina* vs. unvegetated areas from Mar. to July; no apparent selection for vegetation Dec.-Mar.	75-95% found in *Spartina* vs. unvegetated habitat.	Worldwide commercial shrimp harvest proportional to area of vegetated cover in nursery grounds.		81, 101, 139, 140, 158, 159
Vegetation-Substrate availability		Channeling of river, dikes, levees, etc. prevent natural sediment dispersal during spring river floods, losing marsh sediments offshore; results in marsh subsidence and loss of vegetated habitat.			
Chemical Effects		Most sensitive estuarine organisms to pesticides: Organochlorines, DDT, dieldrin, mirex (delayed toxic effect). 0.9 ppb PCB for 2 weeks affects premolt. Malathion: Mortality in marshes when applied by air. No. 2 fuel oil: 24-h TLM: 0.77-2.51 ppm. Carbamate: toxic in lab.	Malathion: Mortality in marshes when applied by air. No. 2 fuel oil 24-h TLM: 0.77-25 ppm.	Effluents (sulfides, phenols, oils): Toxic lethal mean = 4.8% for brown shrimp. Cadmium: LC_{50} for 30 days = 718 ppb, causes blackgill disease. Formalin: 96 h LC_{50} at 28°C = 235-270 ppm. $KMnO_4$: 95 h LC_{50} = 6 ppm. Aroclor 1254: 1 µg/liter is lethal in 2 weeks.	26, 69, 132
Disease and Parasites	Several representatives of fungi, microsporidia, trematodes, cestodes, nematodes, barnacles, bacteria, and viruses infect *P. aztecus*. For more details and extensive bibliographies see Literature Cited.				24, 26, 69, 86, 87, 89, 90, 106, 137

[1]Total length = tip of rostrum to tip of telson.
[2]Sexually mature.

Table 2.—Inshore environmental effects on white shrimp, *Penaeus setiferus*.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Temperature	Collection range: 12.6-30.6°C (6-8 mm). Growth rate (30 days) increases with temperature between 18° and 32.5°C; decreases at 35°C.	10-37°C in ponds if acclimated; growth slow <18°C; Louisiana collected 9-33°C, peaks in abundance 15-33°C. Tolerance to extremes: Summer 3 h LD_{50} = 37°C, nonsummer 3 h LD_{50} = 36°C. Catch ratio increases with temperature <5° >35°C; catch range <5°-40°C; optimum catch 20-38°C; lower limit 4.5°C Georgia.	10-37°C in ponds if acclimated; growth slow <18°C.	Max. summer resistance time at 40°C = 29.5 min. when salinity >10‰ <25‰. Collection range for animals >20 mm: 6.5-39.0°C.	2, 3, 8, 12, 13, 14, 18, 20, 22, 24, 25, 27, 55, 59, 64, 71, 72, 75, 81, 91, 92, 95, 114, 115, 134, 138, 140, 146, 151, 156
Salinity	Collection range: 0.4-37.4‰ (6-8 mm). Growth less at 35‰ compared with 25‰ or lower. Survive salinities of 40‰ for 30 days.	Prefer <10‰; Louisiana collection range: 5-26‰, peaks 5-21‰; Mobile Bay peak 1-15‰; S. Texas 5-10‰; no relation between catch and salinity in range 0-38‰; optimum catch over entire range.	2-35‰ in ponds.	Collection range: 0.4-47.96‰; "prefer lower end of salinity gradient, whatever it may be" (49).	3, 8, 9, 12, 13, 14, 15, 17, 18, 22, 24, 25, 48, 49, 50, 51, 52, 53, 54, 56, 57, 59, 60, 61, 62, 64, 67, 71, 73, 81, 92, 93, 95, 98, 110, 114, 134, 138, 140, 156
Rainfall				Direct correlation between shrimp catch and average state rainfall for previous 2 years (Tex.): 1937-51 r = 0.83, 1927-51 r = 0.80, 1927-64 r = 0.67; not correlated with river discharge in Louisiana.	3, 9, 53, 56, 60, 61, 92, 138
Dissolved O_2		Avoids 1.0, 1.5 ppm.	Stressed ≤2.0 ppm, no stress >4.0 ppm.		13, 85, 94, 97, 114, 118, 121, 122

Table 2.—White shrimp continued.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Substrate	Collected in mud habitat.	Prefer sandy-mud; preference increases with time = offshore training; collected from shallow mud flats to deep channel (loose peat, sand).	Galveston: Prefer sand-silt-clay areas of high organic content.	Prefer sediments with higher organic content than brown shrimp; collected in mud and peat.	39, 46, 81, 92, 103, 113, 125, 134, 140, 149
Vegetation	Collected in *Spartina*.	No consistent pattern of vegetation selection (day or night in lab); prefer vegetation if no other species are present; displaced from vegetation by brown shrimp, and then eaten more by croaker (lab).			1, 44, 81, 92, 101, 103, 113, 140, 158
Food	Omnivorous; prefers *Artemia* over artificial food.	Omnivorous: Organic-inorganic detritus, fecal pellets, diatoms, polychaetes; lab-reared prefer *Artemia* vs. artificial; not as selective as brown shrimp = coexistence.	Omnivorous: Polychaetes, organic-inorganic detritus.		21, 32, 70, 72, 92, 113, 140
Predators on Shrimp	Spotted seatrout, crab megalops, southern flounder, spot, killifish.	Spotted seatrout, sea catfish, red drum, southern flounder, ladyfish, sea birds, pinfish, Atlantic sharpnose shark, blue crab, Atlantic croaker, black drum, silver perch, sand seatrout.	Spotted seatrout, sea catfish, red drum, southern flounder, ladyfish, croaker, pinfish, Atlantic sharpnose shark, blue crab, sea birds.	Information on predation rates in the field is lacking. Penaeids in stomach contents of predatory fishes are seldom identified to species. Predation on offshore populations may not be a significant source of mortality. Little information is available concerning predation on postlarvae in estuaries, but juveniles are frequently fed upon by fish predators.	28, 30, 33, 47, 68, 74, 76, 84, 92, 96, 99, 101, 107, 108, 111, 129, 130, 133, 135, 140, 159
Growth	No growth at 15°C; slow below 18°C; max. = 1.7-2.0 mm/day at 30.5-34.1‰ and 25-31°C.	Mean growth range mm/day (mark-recapture data): 0.0-0.8 (males), 0.03-2.3 (females). 98-133 mm in 4 weeks, 98-146 mm in 6 weeks.		mean mm/wk Aug.-Oct. 1.3 Oct.-Feb. 0.9 Feb.-April 2.0 April-Aug. 1.7	12, 38, 42, 63, 67, 68, 72, 76, 77, 91, 92, 93, 112, 138, 140, 156
Migration	Recruit June-Sept. to bays (Louisiana); recruit late spring-fall (Galveston); recruit May-Oct. (Texas, Mississippi).	Overwinter offshore when bay temp. gets too low; small shrimp reenter bays the following spring when temperatures rise; migrate offshore Aug.-Oct.	Stay nearshore to grow and spawn; tissues generally show no convergence of carbon isotopes with any region of sediments.		7, 9, 25, 35, 37, 38, 68, 75, 77, 82, 91, 92, 93, 117
Location	Near sides of channels vs. mid-channel; planktonic to demersal; tidal passes to interior marsh.	All estuary locations; optimum catch in secondary streams, marshes, and in tertiary, secondary, and primary bays.	Principal spawning depth is 10-15 m (Texas); 15-30 m (Louisiana).		7, 12, 16, 22, 24, 25, 31, 59, 91, 92, 93, 103, 104, 120, 123
Season	Mean size at entry, Aransas Pass: 7 mm—May 8 mm—July 6 mm—Sept. Enter during late spring and summer.	Caught in all months; optimum catch July-Dec.; absent from marshes Jan. thru April; peak abundance = spring, late summer, and fall (inshore Louisiana).	Strong gonadal development May-Sept.; peak abundance fall-winter offshore (Texas).		7, 9, 12, 16, 24, 25, 39, 63, 75, 82, 92, 114, 120, 123, 134, 158
Interactions Salinity-Temperature	80% survival over 50 days at temperatures >33°C and salinity approximately 3-40‰; lower limits approximately 15°C and salinity less than 5‰. Growth reduced at 35‰ at all temperatures tested. Less tolerant of cold than postlarval browns; at lowest temperatures (11-15°C) survival better at higher salinities.	Catch ratio low at all salinities if temperature below 15-20°C; at higher temperature generally distributed in less than 25‰.		Simultaneous change in salinity and temperature has more influence on physiological responses than a single alteration; most effect at combination of extremes.	24, 92, 119, 140, 156, 158
Salinity-Location		Occupy upper estuarine areas during warm season; relying on "contents" of inflowing water.			24
Salinity-Season		Found in all salinities during months when available.			24, 158
Salinity-Size		Better osmotic regulators than adults; hemolymph concentrations may decline below 10‰.			15, 64, 92, 117

Table 2.—White shrimp continued.

Item	Postlarvae (<25 mm[1])	Juveniles	Adults[2]	General comments	Sources
Salinity-Vegetation		*Spartina* adversely affected by salinity intrusion; intertidal condition necessary for germination.			1, 62, 81, 116, 131, 158
Temperature-Migration		Overwinter offshore when bay temperatures drop; may return to bays as temperature rises.			37, 117
Vegetation-Abundance		Not dependent on vegetation; equally abundant in nonvegetated areas.			81, 101, 139, 140, 158
Vegetation-Substrate availability		Channeling of river, dikes, levees, etc. prevent natural sediment dispersal during spring river floods, losing marsh sediments offshore; results in marsh subsidence and loss of vegetated habitat.			1, 5, 36, 81, 131
Chemical Effects		Malathion: Mortality in marshes when applied by air; No. 2 fuel oil: 24-h TLM=0.77-25 ppm; Quinaldine: 25 ppm is the minimum effective anesthetic concentration; 10-20% concentrations cause death in 48 h.			26, 69
Disease and Parasites	Several representatives of fungi, microsporidia, trematodes, cestodes, nematodes, barnacles, bacteria, and viruses infect *P. setiferus*. For more details and extensive bibliographies, see Literature Cited.				26, 69, 86, 87, 88, 89, 106

[1]Total length = tip of rostrum to tip of telson.
[2]Sexually mature.

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Status of Data Sources on Fish Consumption in the United States

D. J. WAGSTAFF, M. MEABURN, M. BOLGER, S. CONRATH, and B. HACKLEY

Introduction

Quantitative information about fish[1] consumption is important from several standpoints. Fish represent a major food source with a growing potential for significant market development as some of the unique nutritional properties of fishery products are revealed through contemporary research. Consumption data bases that are well defined, validated, and accessible would be particularly useful to nutritionists and others in the medical community concerned with the relationships between diet and human health. Marketing specialists, fishery resource managers, and administrators concerned with maintaining an ecological balance in the aquatic environment would also benefit from such information.

As a natural living resource, however, fish are continually exposed to many environmental pollutants and thus are susceptible to contamination by substances which, if admitted to the human diet, may be hazardous to the health of the consumer. Fish constitute the only class of foods subject to total governmental prohibition in large geographic areas of the U.S. for substantial time periods.

The contaminants that have assumed such serious proportions at various times are of several types and sources. They include infectious agents derived from human waste, such as the hepatitis virus and other enteric viruses, natural toxicants such as paralytic shellfish toxins, industrial chemicals such as polychlorinated biphenyls, and some contaminants originating from both industrial and natural sources, such as mercury. The Food and Drug Administration (FDA), National Marine Fisheries Service (NMFS), Environmental Protection Agency (EPA), and other organizations routinely sample fish according to their various mandates to determine levels of many of the more commonly occurring or more hazardous contaminants.

Because both the beneficial and harmful properties of a fish-based diet may differ with species of fish, consumption frequency, and physical condition of the consumer, it is important in public health assessment to estimate the quantity and kind of fish consumed and the demographic distribution of consumption by subgroups of the population. Important factors governing the degree of biologic effect, positive or negative, by a food component are the quantity of that component taken into the body and its chemical form and reactivity.

Despite the importance of information on fish consumption to decisions in public health, law, and business, much of that information is poorly documented. The purpose of this report is to document the existence and characteristics of available data sources and to evaluate the strengths and limitations of each data source. It is neither within the scope of this paper to analyze each data file for distribution of fish intake by fish species or by human population subgroups nor to determine the identity and concentration of potentially beneficial or harmful substances in fish. Such analyses will need to be done later to perform assessments of consumer exposure to fish constituents in the diet. These in turn may be used to guide decision making in health and regulatory agencies regarding the quality and safety of foods derived from fish.

Consumption of fish by the U.S. population has been estimated from three general types of information: 1) Commercial production data on landings, imports, and exports of food fish; 2) national surveys of food intake, including fish, and 3) several national surveys that have been conducted which are specific for fish intake. Per capita consumption can be estimated either by dividing total fish production intended for domestic use by the number of people in the U.S. population or by selectively sampling the fish intake of individuals in the population and extrapolating the results to the entire U.S. population. Many samples of food intake by individuals are available for local areas and restricted population groups but there are a limited number of national samples. The U.S. Department of Agriculture (USDA), starting in 1909, has annually published the average consumption of several types of food such as meat, fish, and vegetables by dividing the total quantity of each food marketed in the U.S. by the population (Friend et al., 1979). These data are useful for general evaluations and study of trends but are of little help in estimating the variation in the amounts of each food eaten by individuals and of even less use in estimating food intake by subsets of the population.

Fish species (organs included), processing steps, and food preparation pro-

[1]The term fish is used throughout this paper to describe both finfish and shellfish of marine or freshwater origin. The fish may be fresh, frozen, canned, or processed in other ways. They may be consumed as a single dish or combined with other foods in mixed dishes.

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cedures are described in varying levels of detail within each data source and among data sources. For example, in the USDA 1965 survey of food intake of individuals (USDA, 1972) there were food codes for 89 dishes composed mainly of fish. Some fish such as halibut were coded separately while other types of fish such as crabs were grouped. There is little or no cross referencing of either the food codes or food names among the various data sources. Therefore, comparisons of estimates of fish intake must be done by manual, ad hoc methods based on varying sets of classification assumptions.

Fish Production Data

Production data are available from NMFS for commercially harvested marine and freshwater fish. Commercial seafood production is closely monitored and reported weekly. These reports are summarized annually in "Fisheries of the United States" (NMFS, 1985). The data are tabulated on balance sheets from which per capita civilian consumption is calculated by accounting for exports, imports, inventory changes, and military purchases. Such a calculated average consumption is on an edible weight basis but is usually greater than the actual human consumption because of seafood lost through spoilage or diverted into pet food or livestock feed. The balance sheet also does not list commercial freshwater fish, recreationally caught fish, or marine fish sold at roadside stands.

Data on recreational catches (NMFS, 1984) are based on rather indirect measures such as intercept survey interviews of fisherman and are generally less useful for estimating production. The USDA calculates annual per capita fish intake by adding an estimate of recreationally caught fish and the other types of data to the commercial seafood production just described to calculate the total fish consumption.

General Food Intake

USDA 1965-66

The first national food intake survey for which detailed information is available for individuals was conducted in 1965-66 (USDA, 1972). A survey was taken of the food intake of 14,519 individuals in April, May, and June, 1965. After household data were gathered, the respondent, usually the homemaker, was asked for information on all foods eaten by each household member in the previous 24-h period. The survey was designed to sample all days of the week equally. Considerable demographic and socioeconomic data were recorded but geographic area was only coded down to the level of the nine national census divisions, each comprised of several states. A magnetic tape copy of survey results was provided to the FDA in April 1971. The individual survey results have been used extensively in estimating exposure to food additives and contaminants. This survey has also been used by the EPA for exposure assessment and risk assessment. [A copy of the survey data can be obtained on magnetic tape from the National Technical Information Service (NTIS), Springfield, VA 22161 (PB 80-195145/HAE Nationwide Food Consumption/Individual - Spring Qtr 1965).]

Documentation of the survey design and procedures is available but, as often happens with large data bases, there are some discrepancies among different editions of the file. For example, although the original results were reported for 14,519 surveyed people, the file supplied to the FDA contained records for only 14,352 people. Only dishes composed mainly of fish or shellfish were included in the published report in the fish and shellfish category (USDA, 1972). Mixed dishes such as fish pot pie were tabulated with other mixed meat dishes containing other types of meat, including beef and pork, in a category called mixtures. The detailed data are still available and the total intake of fish could be calculated for each individual in the survey if recipes were available from which to estimate the proportion of fish in each mixed dish. However, there is no national file of standard recipes. Such a file could be created but it would be difficult to do because of the large size of the project and the relative unavailability of recipes for proprietary food products. Fish intake during the spring months of this survey is probably not the same as for other seasons such as the recreational fishing season in the summer. For this reason, data from this survey are not suitable for determining seasonal patterns of fish consumption.

USDA 1977-78

A national survey of food intake, called the Nationwide Food Consumption Survey, performed by the USDA in 1977-78 was expanded from the one in 1965-66 (Pao et al., 1982). The individual intake portion of the survey, comprising 30,770 people, was carried out in all seasons of the year, and contained food intake data over a 3-day period for each person. One person, usually the homemaker, was asked to recall the identity and amount of each food item eaten at each meal or snack by every household member during the prior 24 hours and to keep a diary of such information for the next 2 days. Respondents were also asked if the day's intake was typical and if they were on a special diet, were vegetarians, or took vitamins, minerals, or other supplements. Extensive demographic and socioeconomic data were recorded for each sampled person but the geographic area of residence was coded only to a multistate census division level. [Copies of the data tapes involved may also be obtained from NTIS (PB 80-190218/HAE Nationwide Food Consumption Survey/Individual-Spring Qtr 1977-78, PB 80-197429/HAE Nationwide Food Consumption Survey/Individual-Summer Qtr 1977-78, PB 80-200223/HAE Nationwide Food Consumption Survey/Individual-Fall Qtr 1977-78, and PB 81-118853/HAE Nationwide Food Consumption Survey/Individual-Winter Qtr 1977-78).]

NHANES I

The first National Health and Nutrition Examination Survey (NHANES I) of about 32,000 people aged 1-74 years in the U.S. was conducted by the National Center for Health Statistics in 1971-75. Food intake was obtained for a subset of 20,749 people aged 1-74 through a 24-h dietary intake recall interview and a food frequency interview. However, food eaten on weekends

was seldom recorded. Health status was determined through interviews, physical examinations, and other diagnostic procedures. In addition, a subset of people aged 25-74 was examined in greater detail for arthritic, respiratory, cardiovascular, and other conditions. NHANES is the only type of national survey in which food intake and state of health were determined in the same people. The sampling design was complex; the sampling was stratified and therefore was not uniform over all parts of the country and all subgroups of the population. There were limited geographic sampling sites and oversampling of some groups such as persons with low income, preschool children, women of child-bearing age, and the elderly. For logistical reasons, sampling was done in the north in the summer and in the south in the winter. [A copy of the data tape on food consumption is available from NTIS (PB-297339/HAE HANESI - 24 Hour Food Consumption Survey No. 4704). Dietary frequencies and medical examination results are on other tapes available from NTIS.]

NHANES II

Data similar to NHANES I were collected in NHANES II in 1976-80 through response to questionnaires on medical history, food consumption, and health-related behavior. Data also were collected through direct medical examination. NHANES II was conducted on a nationwide probability sample of 20,322 persons ages 6 months to 74 years from the civilian noninstitutionalized population of the United States. Food consumption data are in the form of quantities of food consumed and frequency of eating in a 24-h recall period. [A copy of this tape can be obtained from NTIS (PB 82-142639/HAE HANESII - 24 Hour Recall - Spec Food/Cat 5704). Dietary frequencies and medical examination results are on other tapes available from NTIS.]

Proprietary Surveys

Some proprietary surveys of food intake are available. One of the largest of these is a sample of food frequency conducted periodically by the Market Research Corporation of America (MRCA)[2]. The food products purchased by each of the 4,000 sampled households of each survey, which is inappropriately called a menu census, are described in detail by MRCA and the frequency of the consumption of each food is recorded in daily diaries over a 2-week period. The quantity of each food eaten by each person is not recorded; however, brands and food packaging materials are described. The sample is balanced as closely as possible within each quarter to the U.S. census by various demographic socioeconomic variables. Because the data are owned by a private company, access to the information is limited and is available only on a fee-for-service basis. The 1976 special search on fish consumption conducted on Menu Census 4 data by MRCA for the FDA does not provide the specifics needed to estimate consumption of fish by species. [Further information can be obtained from MRCA, 2215 Sanders Rd, Northbrook, IL 60062.]

Fish Intake

A closer look at fish intake data sources will convey some idea as to the exact coverage of the data and the degree of confidence which can be placed in them.

Market Facts 1969-70

A national survey of fish purchases was conducted in 1969-70 by Market Facts, Inc., under contract to the NMFS. It comprised a 1-year fish purchase diary survey of 1,586 households (4,864 individuals) in the United States. Each household completed a diary twice monthly of fish purchased by species. Purchases were recorded for households, not for individuals. Only fragmentary documentation for the methods and survey results is available. The original database is now irretrievable despite attempts at reconstruction. It cannot be determined exactly how the quantity of fish in mixed dishes was calculated. There are also conflicting reports on the inclusion or exclusion of gamefish in the database. Despite these uncertainties the average fish intake was in general agreement with the NMFS annual balance sheets. The final report is available from the Office of Utilization Research, NMFS, NOAA, Washington, DC 20235.

[2]Mention of trade names or commercial firms or products does not imply endorsement by the National Marine Fisheries Service, NOAA.

NPD 1973-74

A national fish intake survey of 7,662 households comprising 25,165 people was conducted in 1973-74 by NPD Research, Inc., with funding from the Tuna Research Foundation (TRF). Participants kept a diary for 30 days of all intake of fish and recorded the total intake of each species of fish by family members for each day. A magnetic tape copy of the survey results was obtained by the NMFS. An adhoc committee of FDA, USDA, NMFS, and TRF representatives reviewed the data, revised them as seemed necessary, and apportioned intake among family members of different age and sex groups by use of average portion size data from the 1965 USDA survey if portion sizes had not been reported by the panel member. A subfile of the 24,652 persons who reported eating fish during the 30-day period was provided to the FDA. Although the survey seems to have been well conducted, documentation of methods and results is not complete. In addition, records are lacking for those who ate no fish. There is insufficient information to determine how the proportion of fish in mixed dishes was calculated. [A copy of this tape can be obtained from NTIS (PB 294725/HAE Fish Consumption Data 1973-1974).]

MRCA 1980-81

MRCA, under NMFS contract, performed a national survey of fish intake in 1980-81. The survey was designed to collect from its total National Consumer Panel (NCP) of 7,500 households, representative of all U.S. households, augmented to include Alaska and Hawaii, written records of each of their purchases of fish, shellfish, or products made from them, on a continuing basis through the NCP weekly diary for a 52-week period. Each household provided complete details on every such item brought into the home, either purchased, caught recreationally, or received as a gift. The information was

recorded in appropriately designed diary sections, and returned to MRCA at the end of the week. As far as possible, the same households continued to report for the full 12-month period. Dropped households were replaced to maintain a demographically balanced sample of 7,500 reporting households.

At the same time, each of these households also recorded in a special monthly diary, for one month per quarter, each occasion of serving and eating fish or fish products, or dishes made from them. All fish meals were included, whether prepared and eaten at home, obtained and eaten away from home, carried and eaten away from home, or caught and recreationally eaten "in the field" by any member of the household. Each eater was identified, including guests, by age and sex. Different thirds of NCP were covered each month of every quarter through the year. An extensive set of demographic characteristics was collected from each household, and from each individual in the household.

Part of the survey results pertaining to purchases and attitudes have been released but the data for fish intake per se have not. Inquiries about availability of these data should be addressed to the Chief, National Fisheries Statistics Program, NMFS, NOAA, Washington, DC 20235.

Analyses

Despite deficiencies in obtaining and documenting data on fish intake, different estimates of per capita intake of fish are fairly close. One of the more recent and extensive reviews of fish intake data sources was done by SRI International for the EPA to aid EPA in evaluating the hazard of water contaminants (Javitz[3]).

Wagstaff (1983) found that, during the decade from 1965 through 1974, the range over the nine data sources evaluated was about 10-20 g/day. Part of the difference is probably due to an overall increase in fish intake over the 10-year period. The NMFS has contracted with Pennsylvania State University to consolidate and analyze fish intake data from four of the data sources described in this report. Results of that contract have not been released because the results of the MRCA 1980-81 survey have not become available.

Fish Recipes

It is difficult to determine the type and species of fish eaten or the quantity of fish eaten when the fish is part of a mixture of fish and other ingredients. At present, there is no set of standard recipes of fish dishes which is used to determine the proportion of each dish that is fish. Because of this lack, fish intake estimates have to be based on assumptions regarding proportion of fish in mixed dishes. Efforts are being made to locate recipes of dishes containing fish and to construct a table of proportions of fish by species in mixed dishes.

Discussion and Conclusions

Coverages of the various fish intake data sources overlap to a large degree but are not identical. There are inconsistencies, missing data, lost documentation, and implausible survey results. Thus it was surprising that the per capita consumptions of fish estimated from various of the data sources are relatively close (Wagstaff, 1983). Although survey design could be improved, the major area needing improvement is quality control in conducting a survey, including preserving and processing the data, documenting the whole survey process, and issuing final reports. The funding organizations do not expend sufficient effort in monitoring the contractors' work and in analyzing data and interpreting them to address societal needs. The cause of exposure assessment would be better served by conducting fewer surveys with high quality followup on each survey. It is our view that, for the present, efforts should be diverted from planning new surveys to adequate analysis of data from past surveys.

There are several other factors which should be considered in evaluating food exposure data. Some of these have been discussed by Wagstaff (1982). The calculation of per capita food consumption from production totals can apply only to a single national average. Surveys of individual food intakes provide estimates of distributions of food intake within the population for age, race, sex, and socioeconomic groups. But geographic distribution is available only at the regional or state levels. The number of people sampled is generally too small to derive any reliable estimates at the county level, and it is unlikely that a large enough survey of food intake will ever be taken to obtain county level data for the entire country.

The moderate differences in the various sources of data on food intake should give pause to blind acceptance of food intake data. Sometimes food intakes are calculated to several digits past the decimal. Such detailed presentation is misleading. On the other hand, the general agreement of estimates from different data sources engenders confidence that the estimates are close to reality. Decisions should not be postponed indefinitely while waiting for ultimate proof. Instead, exposure assessments should be done and decisions made as they are needed based on the best information available at the time and then revised if necessary when better information becomes available.

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The Resurgence of the U.S. Swordfish Market

DOUGLAS W. LIPTON

Introduction

Once avoided by consumers because of mercury contamination, the swordfish, *Xiphias gladius*, is today making a comeback. As fears about contamination have waned and the trend toward more "upscale" seafood products has grown, the demand for swordfish has risen. But this resurgence has brought marked shifts in the swordfish market. Today, U.S. landings supply about 52 percent of consumption, compared with 13 percent in 1970. Continued growth in demand, however, may mean a return to a larger share for imports.

This paper will attempt to explain the current trends in the U.S. swordfish market and to project changes to 1995. To understand how the discovery of mercury contamination affected the swordfish market, historical trends are examined from 1965 to 1985. Using this time period, a regression model is used to estimate the demand for swordfish. The model incorporates a feature that allows the mercury discovery to affect the demand for swordfish in the year that it was discovered and subsequent years. However, as time progresses, the model allows the impact of the mercury discovery to lessen as consumers forget[1]. Thus, the model is used to make projections in a period where mercury levels are no longer perceived as a factor in swordfish demand.

The U.S. Swordfish Market, 1965-70

Prior to 1971, the U.S. swordfish market was dominated by imports which totaled over 7 million pounds of fillets and steaks a year (Fig. 1). On the other hand, U.S. landings were typically below 2 million pounds (round weight) annually. Because the market was dominated by imports, it is not surprising that ex-vessel prices moved in proportion to import prices. Both import and ex-vessel prices showed a slightly increasing trend over the period (Fig. 2). World swordfish landings during the period rose from about 32,000 metric tons (t) in 1965 to 38,000 t in 1970 (Fig. 3). U.S. landings made up only 4 percent of world landings in 1965, and fell to 1 percent by 1970.

In terms of consumption, the U.S. population consumed between 16 and 18 percent of the world swordfish production during the period. U.S. per capita consumption totaled between 0.04 and 0.05 pounds of swordfish per year (Fig. 4).

The U.S. Swordfish Market, 1971-80

In 1971, concentrations of mercury exceeding the U.S. Food and Drug Administration's (FDA) action level of 0.5 ppm were found in swordfish (D'Itri and D'Itri, 1977). Swordfish that were either imported or transported interstate were subjected to FDA inspection and possible seizure if found to exceed the action level. News reports warned consumers of the dangers of eating swordfish with high mercury concentrations. As a result, swordfish consumption dropped 96 percent to less than 0.002 pounds per capita in 1971. By 1980, per capita swordfish consumption had rebounded to about 0.03 pounds.

Swordfish imports plummeted from almost 8.8 million pounds in 1970, to 169,000 pounds in 1971. U.S. landings also fell from almost 1.6 million pounds (round weight) in 1970 to only 233,000 pounds in 1971.

In 1977, no swordfish imports were reported, but by 1980, imports had risen to 478,000 pounds. The rebound in U.S. landings was rapid and dramatic, reaching 1.5 million pounds in 1973 and topping 9.1 million pounds in 1980.

To understand the growth in U.S. landings of swordfish, it is helpful to examine what happened to swordfish prices from 1971 to 1980 (Fig. 2). Despite discovery of the mercury problem, real ex-vessel price for swordfish actually increased 5 percent in 1971, over 50 percent in 1972, and another 15 percent in 1973. In 1974, ex-vessel price adjusted downward 32 percent, rebounded a little in 1975, and remained flat through the remainder of the decade.

At the same time that ex-vessel prices were increasing, import prices were decreasing. Real import prices fell 11 percent in 1971 and an additional 42 percent in 1972. The requirement for inspection of imported swordfish for mercury had differentiated the imported and domestic product. Domestic swordfish landed and marketed in the same state were not subject to FDA inspection and seizure, even though the mercury levels might exceed the FDA action level. Thus, seafood dealers had a higher demand for swordfish that could be landed and marketed in the same state relative to imported swordfish or swordfish that had to be transported across

[1]See Swartz and Strand (1981) for a similar analysis of the effect of news of Kepone contamination on oyster prices.

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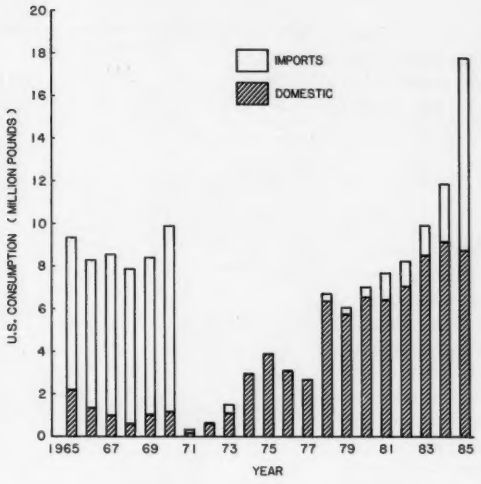

Figure 1.—U.S. consumption of swordfish by source.

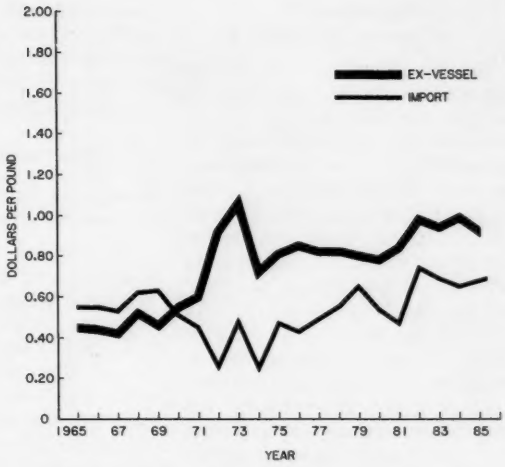

Figure 2.—Real ex-vessel and import swordfish prices, 1965-85 (deflated by producer price index for all products; 1967 = 100).

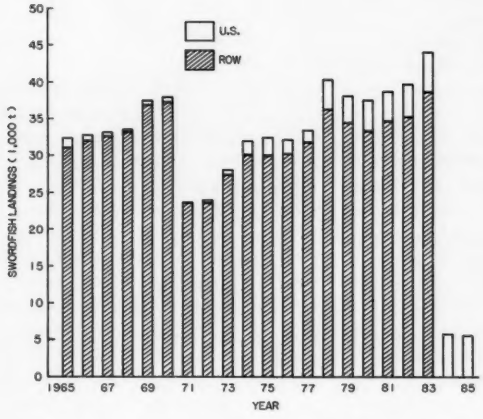

Figure 3.—U.S. and rest of world (ROW) swordfish landings, 1965-85. ROW landings unavailable for 1984-85.

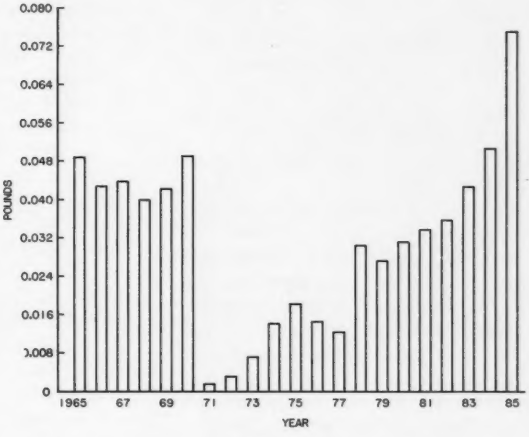

Figure 4.—U.S. per capita consumption of swordfish, 1965-85.

state lines. This demand differential was reflected in the difference in ex-vessel and import prices. U.S. fishermen responded to these price signals by increasing their production of swordfish.

From 1975 to 1980, import prices slowly regained ground lost from the 1971 mercury discovery, but import quantities barely recovered.

The entire world market was affected by the mercury problem. World landings dropped 37 percent in 1971. By 1980, the U.S. accounted for 11 percent of the world swordfish catch and 12 percent of its consumption.

The Swordfish Market, 1980-86

The upward trend in U.S. landings begun in the mid-1970's has continued to the present (1986). Imports, however, recovered slowly until 1985 when they increased 330 percent over 1984 levels. However, the 1985 total was still only 3 percent higher than in 1970. The increase in imports was accompanied by a 5 percent rise in real import price, which includes the effect of the dollar exchange rate. Thus, the rise in the value of the dollar, which makes imports cheaper, cannot account for the increase in imports. It is more likely that there has been a surge in demand for high value fishery products such as shrimp, fresh salmon, fresh tuna, and swordfish. This is further substantiated by the fact that preliminary data through May 1986 show swordfish imports up 75 percent over the same period in 1985 despite a 10 percent rise in real import price. Another explanation for the increase in imports may be due to mistakenly including transhipments of swordfish caught by U.S. fishermen through foreign countries in the import statistics. However, since these transhipments are not counted as U.S. landings, the overall effect of increased swordfish supply on the U.S. market is unchanged.

Per capita swordfish consumption increased steadily over this period from about 0.03 pounds per person in 1980 to just over 0.05 pounds in 1984, then took a big jump to almost 0.08 pounds per person in 1985. This increase in per capita consumption in 1985 was accompanied by an 11 percent decrease in real swordfish price[2]. Until landings data become available, it is not possible to determine whether the continued surge in imports in 1986 is being partially fueled by a decline in domestic landings. If domestic landings remain at levels similar to the most recent 3 years, and imports continue to arrive at a pace 75 percent ahead of 1986, per capita consumption in 1986 would be 0.1 pounds, a 25 percent increase over 1985.

Data for world swordfish landings are not available after 1983. If world landings in 1985 are similar to 1983 levels, then U.S. consumption accounted for an estimated 25 percent of the world's swordfish in 1985.

[2]An index of swordfish price which is a weighted average of import and ex-vessel price is used here.

The Swordfish Market

Forecasting Equation for Swordfish Demand

The equation used for forecasting swordfish demand was estimated using the Shiller polynomial distributed lag (Judge et al., 1985). The lagged variable was a dummy variable equal to one in the year 1971 when high concentrations of mercury were discovered in the swordfish, and zero for all other years. The lag periodicity chosen was 5 years including the current year, and a first-degree smoothness prior was chosen. Other variables included were swordfish price (a weighted average of import and ex-vessel prices), per capita disposal income, and the consumer price index for the substitute product, beef. All variables were adjusted for inflation and regressed on the natural logarithm of per capita swordfish consumption.

The above model performed well in regard to expected signs and the overall significance level; however, the largest residuals were obtained for the most recent years (1985-86), where per capita consumption was underestimated. It appears that a structural shift has increased the demand for swordfish, and this was modeled by including another dummy variable set at one for 1985 and 1986, and zero for all other years. This model performed much better in predicting the most recent data, and it is felt, gives more reasonable forecasts. The coefficients of the forecasting equation and associated t-statistics are given in Table 1. All coefficients had expected signs. The r^2 for the equation was 0.91.

Table 1.—Coefficients and t-statistics of swordfish demand for forecasting equation.

Variable	Coefficient	t-Statistic
Constant	−7.25	−2.59
Swordfish price	−0.61	−0.43
Per capita disposable income	1.9×10^{-4}	0.83
CPI for beef	2.43	1.56
Dummy for mercury (D)	−3.19	−7.33
D(−1)	−2.51	−6.01
D(−2)	−1.81	−4.28
D(−3)	−1.08	−3.13
D(−4)	−0.40	−1.04
Dummy for structural change	1.04	2.72

Swordfish Market Projections

Details on the model used to make projections about the U.S. swordfish market have already been given. Per capita consumption of swordfish is assumed to be a function of real swordfish price, real per capita disposal income, and the extent of knowledge regarding the levels of mercury found in swordfish. In 1971, mercury contamination of swordfish was headline news, but over time it appears that people have forgotten about the mercury levels. The model used allows the separation of price and income effects on swordfish consumption from the effects of the mercury scare. Thus, changes forecast in the economy through the disposable income variable can be used to forecast changes in per capita swordfish consumption. Population forecasts are then used to convert per capita swordfish consumption to total consumption.

Table 2.—Projection of per capita consumption (PCCONS), total consumption (TCONS) and imports of swordfish.

Year	PCCONS (lb.)	TCONS (10^3 lb.)	IMPORTS (10^3 lb.)
1985[1]	0.075	17,808	9,052
1986	0.086	20,778	12,723
1987	0.091	22,274	13,702
1988	0.095	23,411	14,840
1989	0.098	24,298	15,727
1990	0.102	25,712	17,141
1991	0.108	27,168	18,597
1992	0.112	28,554	19,983
1993	0.116	29,799	21,228
1994	0.119	30,756	22,185
1995	0.122	31,820	23,249

The model forecasts that with no change in real swordfish price, per capita consumption in 1986 will be 0.09 pounds, slightly less than the 0.1 pounds predicted if imports continued at the rate they did through May 1986 (Table 2). Between 1988 and 1990 per capita consumption will reach 0.1 pounds, and by 1995 it will reach 0.12 pounds. Because of population growth, this means that 25.7 million pounds of swordfish will be

consumed in 1990, and 31.8 million in 1995 compared with the 18 million pounds in 1985. With U.S. catch in round weight remaining around the 12 million pounds mark, imports in 1990 will be 17.1 million pounds, and in 1995, 23.2 million pounds, 89 and 156 percent increases over the 1985 import level, respectively.

The above estimates assume no change in real swordfish price from the predicted 1986 price. If, however, the U.S. dollar exchange rate with the swordfish exporting countries were to change, the predictions would shift accordingly. A further devaluation of the dollar would make swordfish imports more expensive, lowering per capita consumption and total imports. A rise in the value of the dollar would have the opposite effect. However, the price effects are small. At the 1986 values, a 1 percent rise (decline) in swordfish price will lower (raise) per capita consumption less than 0.5 percent.

Summary and Conclusions

In 1986, the U.S. swordfish market overcame the weakness in demand created by the discovery of high concentrations of mercury, and consumption was at record levels. In the 1960's the swordfish market was dominated by imports, but today a substantial portion of the supply is from domestically caught swordfish. This analysis has shown that the FDA regulations for inspection of imported swordfish and the likelihood of seizure of contaminated products, created an opportunity for the development of the U.S. fishery. Higher prices for domestic swordfish sparked an increase in investment in the U.S. fishery. As consumers forgot about the mercury issue, swordfish demand increased, allowing further expansion of the domestic harvest and the slow return of imports. In 1985 and 1986, seafood demand in general appears to be up due to rising consumer incomes, the related increase in away-from-home food purchases, and the image of seafood as a healthy food. Swordfish is benefitting greatly from this new surge in demand.

The outlook for the swordfish market looks bright. As consumer incomes continue to rise and the U.S. population grows, both domestic fishermen and importers can expect continued high prices as demand for swordfish increases. The one major unknown in the future of the market is the mercury issue. Inquiries with FDA indicate no change in their enforcement of the 1.0 ppm methyl mercury action level. Thus, it may be that more swordfish is being landed with mercury levels lower than in the past. No studies have been conducted to determine if this is true. Relatedly, the 1.0 ppm action level was partially based on the fact that per capita consumption was greatly reduced due to consumer awareness of high levels of mercury in swordfish. The present and projected higher per capita consumption levels might induce the FDA to reexamine the 1.0 ppm action level for mercury in swordfish. If this were to occur, swordfish consumption would be expected to fall due to the effect of negative publicity on demand and the effect of the higher action level on supply.

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U.S. Tuna Trade Summary, 1984

SAMUEL F. HERRICK, Jr., and STEVEN J. KOPLIN

Introduction

For much of the U.S. tuna industry, 1984 was a year of frustration and disappointment. As the year ended, the only continental tuna cannery remaining in operation was Pan Pacific Fisheries located at Terminal Island, CA. Two California canneries, Van Camp and Star-Kist, shut down their mainland tuna processing operations in favor of lower cost production at offshore sites, primarily in American Samoa and Puerto Rico. The closure of these canneries left about 2,400 cannery workers without jobs. Businesses that supply the canneries with goods and services and the tuna vessels that traditionally have relied on the canneries located in California to purchase their catches were also severely affected by the closures.

With the tremendous reduction in California canning capacity and a 20-30 percent decline in ex-vessel prices during 1984, vessels participating in the fishery found themselves in a desperate economic situation. Many of the larger, more mobile vessels were able to survive 1984 by operating throughout the Pacific, delivering their catches to offshore sites. Nonetheless, the cannery closures and depressed ex-vessel prices forced a significant number of California-based vessels out of the fishery. By the end of the year the tropical tuna fleet declined by 12 percent. Ten vessels transferred flag, nine were chartered to foreign interests, and three were converted for operation in the North Pacific trawl fisheries.

According to the U.S. tuna industry, foreign competition was the most significant factor contributing to the cannery closures and economic problems of the fleet during 1984. From 1979 through 1984 the amount of canned tuna imported into the U.S. more than tripled (Table 1), increasing by almost 40 percent between 1982 and the end of 1983 alone. This increase has consisted almost entirely of tuna canned in water which has surpassed tuna packed in oil in popularity among U.S. consumers and is subject to a much lower import duty than tuna packed in oil. The problem of canned inports was considered severe enough to prompt various segments of the industry (vessel owners, processors, and cannery workers) to join together and petition the U.S. International Trade Commission (ITC), under Section 201 of the Trade Act of 1974, for

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Table 1.—U.S. supply of canned tuna, volume and value, 1974-84.

	Domestic production						
	White[1]		Light[2]		Imports[3]		
Year	Amt.	%[4]	Amt.	%	Amt.	%	Total
Case pack volume (1,000 cases)							
1974	8,162	22.6	25,202	69.9	2,705	7.5	36,069
1975	5,014	17.0	21,788	74.0	2,650	9.0	29,452
1976	5,966	17.9	24,339	73.0	3,020	9.1	33,325
1977	6,221	21.2	21,439	72.8	1,776	6.0	29,436
1978	7,120	18.6	28,515	74.5	2,655	6.9	38,290
1979	5,805	17.0	25,598	74.9	2,754	8.1	34,157
1980	5,505	16.3	25,003	74.0	3,259	9.7	33,767
1981	5,826	16.4	25,928	73.3	3,633	10.3	35,387
1982	6,020	19.1	21,067	66.7	4,491	14.2	31,579
1983	5,127	14.2	24,814	68.5	6,273	17.3	36.214
1984	6,584	16.7	24,461	62.1	8,324	21.1	39,369
Case pack value ($1,000)							
1974	238,518	27.3	585,375	66.9	51,108	5.8	875,001
1975	136,678	19.6	515,957	73.8	45,951	6.6	698,586
1976	212,869	23.1	640,594	69.6	67,502	7.3	920,965
1977	240,734	25.3	665,880	70.0	44,658	4.7	951,272
1978	296,506	22.2	976,754	73.0	63,822	4.8	1,337,082
1979	243,851	20.9	859,998	73.6	65,071	5.5	1,168,920
1980	252,290	20.3	891,237	71.9	97,254	7.8	1,240,781
1981	294,292	22.8	885,846	68.6	110,359	8.6	1,290,497
1982	275,400	26.7	643,046	62.3	113,346	11.0	1,031,792
1983	197,011	19.8	661,586	66.4	137,324	13.8	995,921
1984	255,962	24.6	616,280	59.3	167,268	16.1	1,039,510

[1]Standard case: 48 7-ounce solid pack.
[2]Standard case: 48 6.5-ounce chunk pack cans and 48 6-ounce cans of grated flake pack cans.
[3]Standard case: 48 6.5-ounce chunk pack cans.
[4]A % symbol denotes the percent of total for each canned category.
Sources: Domestic: Fisheries of the United States, 1975-84. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv. Curr. Fish. Stat. 6900, 7200, 7500, 7800, 8000, 8100, 8200, 8300, 8320, 8360, var. pagin. and, Canned Fishery Products, 1974-83. Curr. Fish. Stat. 6701, 6901, 7201, 7501, 7801, 8001, 8101, 8201, 8301, 8319, var. pagin. Imports: U.S. Dep. Commer., Bur. Census Computerized data files, 1974-84.

Table 2.—U.S. tuna cannery receipts (short tons) by processing site and direct exports, 1979-84.

Source and species	California-American Samoa-Hawaii							Puerto Rico						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
Domestic														
Albacore	8,518	8,078	14,855	6,965	10,466	10,323	9,776	12	20	2		4	3,565	8
Skipjack	64,641	99,386	83,880	82,669	113,465	94,152	88,808	29,980	15,781	13,950	18,781	41,608	51,441	24,020
Yellowfin	112,349	100,523	100,117	93,468	90,052	59,907	99,302	30,042	18,693	26,049	24,800	30,044	35,193	25,926
Subtotal	185,508	207,987	198,852	183,102	213,983	164,382	197,886	60,034	34,494	40,001	43,581	71,656	90,199	49,954
Imported[2]														
Albacore	36,166	37,664	43,241	33,929	22,750	21,962	34,750	50,773	46,147	44,056	60,670	50,105	70,882	50,350
Skipjack	100,887	103,556	72,189	45,837	50,633	26,737	74,621	87,683	105,075	115,820	82,178	84,675	106,136	95,086
Yellowfin[1]	40,646	36,091	39,293	17,811	14,081	12,685	29,584	33,174	38,382	44,295	33,402	24,251	29,045	34,701
Subtotal	177,699	177,311	154,723	97,577	87,464	63,384	138,955	171,630	189,604	204,171	176,250	159,031	206,063	180,137
Grand total	363,207	385,298	353,575	280,679	301,447	227,766	336,841	231,664	224,098	244,172	219,831	230,687	296,262	230,091

	Direct exports[3]							Total						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
Domestic														
Albacore				62		108	12	8,530	8,098	14,857	7,027	10,470	13,996	9,796
Skipjack	1,961	918	292	387	45	14,385	721	96,582	116,085	98,122	101,837	155,118	159,978	113,549
Yellowfin[1]	3,945	1,339	1,087	3,864	538	15,077	2,155	146,336	120,555	127,253	122,132	120,634	110,177	127,383
Subtotal	5,906	2,257	1,379	4,313	583	29,570	2,888	251,448	244,738	240,232	230,996	286,222	284,151	250,728
Imported[2]														
Albacore								86,939	83,811	87,297	94,599	72,855	92,844	85,100
Skipjack								188,570	208,631	188,009	128,015	135,308	134,873	169,707
Yellowfin[1]								73,820	74,473	83,588	51,213	38,332	41,730	64,285
Subtotal								349,329	366,915	358,894	273,827	246,495	269,447	319,092
Grand total	5,906	2,257	1,379	4,313	583	29,570	2,888	600,777	611,653	599,126	504,823	532,717	553,598	569,820

[1]Includes bigeye, blackfin, and bluefin tuna.
[2]Includes only imported tuna destined for canning; exludes tuna imported as flakes, tuna not fit for human consumption, and "sushi" grade tuna.
[3]Includes tuna landed directly or transshipped to a foreign country; excludes tuna exported from the east coast.
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

tariff relief from imports of canned tuna packed in water [Int. Trade Comm. Docket No. 1034, 1984].

Although the ITC acknowledged that the tuna industry was facing difficult times, the Commission decided that the substantial increases in imports of relatively low-cost tuna canned in water, while a contributing factor, was not the primary cause of the industry's current economic plight. Rather, the majority of Commissioners found that overinvestment in boats, plants, and inventories during a period of exceptionally high interest rates was just as important, if not more so, in bringing about the industry's present economic condition (ITC, 1984). This finding thwarted industry's bid for tariff relief to limit the flow of canned tuna imports. A subsequent attempt by the industry to have the U.S. Congress enact protective tariff legislation also failed.

With the cannery and vessel dislocations that occurred during 1984, domestic cannery receipts[1] of imported and domestically caught albacore, *Thunnus alalunga* (white meat), and tropical (light meat) tunas (skipjack, *Euthynnus pelamis*; yellowfin, *Thunnus albacares*; blackfin, *T. atlanticus*; bluefin, *T. thynnus*; and bigeye tuna, *T. obesus*) were slightly below those for 1983. The total volume was 524,028 short tons (t), a decrease of less than 2 percent) from the total volume for 1983 and 8 percent below the 1979-1983 average volume of annual cannery receipts (Table 2). Domestically caught cannery deliveries amounted to 254,581 tons, 11 percent below the 1983 level but 3 percent above the 1979-83 average. Imports made up the 269,447-ton balance in total cannery supplies for 1984, a 9 percent increase in raw tuna imports from 1983 imports but 16 percent below the 1979-83 average.

A significant occurrence in 1984 was the increase in deliveries and transshipments of U.S.-caught tropical tuna to foreign canneries. The U.S. fleet landed 29,570 tons of tuna for export, most of which was transshipped to canneries in Thailand, Japan, and Italy. This compares to only 583 tons exported in 1983 and a 1979-83 annual average of 2,888 tons. When exports of domestically caught raw tuna are combined with deliveries of domestically caught tuna to U.S. canneries, total U.S. deliveries amounted to 284,151 tons for 1984, less than 1 percent below the corresponding

[1]Cannery receipts include only tuna destined for U.S. canneries. Cannery receipts exclude U.S.-caught tuna landed at foreign sites, U.S.-caught tuna landed at U.S. sites that is destined for foreign canneries, U.S.-caught tuna destined for the fresh-fish market, tuna imported as flakes, imported tuna not fit for human consumption, and imported "sushi" grade tuna.

amount for 1983 (Table 2). The surge in U.S. exports is an indication of the internationalization of tuna trade in general and, more specifically, a possibly increasing reliance of U.S. vessels on foreign markets.

The western Pacific Ocean[2] continued to be the most productive tuna fishing area during 1984, accounting for 188,000 tons or 66 percent of the total receipts of domestically caught raw tuna and U.S. exports of raw tuna by oceanic area. This represents a 10 percent increase from 1983 and is three times the 1979-83 average volume of annual cannery receipts of domestically caught tuna and raw tuna exports from this area.

Despite the loss in U.S. west coast processing capacity and intense competition from foreign producers, overall U.S. canned tuna production in 1984 rose 4 percent from 1983. Total volume was 31.0 million standard cases[3], 3 percent above the 1979-83 average total annual volume. When canned imports were combined with U.S. production, the total addition to U.S. canned supplies was 39.4 million standard cases for 1984 which was 8 percent above 1983 and 15 percent above the 1979-83 average annual additions to canned supplies (Table 1).

Increased competition between foreign and domesticaly produced canned tuna has been beneficial to U.S. consumers. The retail composite canned tuna price, which decreased nearly 7 percent during 1983, fell an additional 3 percent in 1984. The downward price trend contributed to corresponding growth in overall apparent consumption which increased 2 percent in 1984, following an increase of 7 percent for 1983. Water-packed products led sales in all categories during 1984, with a gain of almost 10 percent from 1983. Since these items account for more than 60 percent of total sales, this increase helped offset reduced sales of light tuna in oil and of health-oriented, canned tuna products.

[2]In this paper, the eastern and western Pacific are distinguished at long. 150°W.

[3]A standard case can consist of: Solid 48 (7-ounce) = 21 pounds; Chunk 48 (6.5-ounce) = 19.5 pounds; Grated/Flake 48 (6-ounce) = 18 pounds.

In the following sections, the 1984 production of white and light meat tuna by the U.S. tuna industry and consumption of tuna products by U.S. consumers is reviewed in more detail. In the final section some of the issues and events that affected the industry's performance in 1984 are analyzed. Unless otherwise noted, the information and data presented were compiled by the Industry Analysis and Information Section of the Southwest Region, National Marine Fisheries Service, NOAA.

U.S. Albacore Production

Albacore, which in the United States is the only species that may be labelled as white meat tuna (USFDA, 1985), showed all-around trade improvement in 1984. According to industry reports, consumption of canned white meat tuna increased nearly 1 percent for oil pack and 6 percent for water pack during 1984. Total cannery receipts (domestically caught albacore plus imports) reached 106,732 tons in 1984, 28 percent above receipts for 1983 and the highest they have been in the past 5 years (Table 2). Domestic white meat production for 1984 amounted to 6.6 million standard cases, 28 percent ahead of 1983 production and 16 percent greater than the 1979-83 average. The substantial gains in cannery deliveries and domestic production in 1984 probably reflected the industry's expectations of continued growth in consumption, which had increased substantially during 1983.

The U.S. albacore fishery presently occurs entirely in the Pacific Ocean north of lat. 25°N and off the west coast to about long. 180°. This area is divided at long. 140°W into offshore (mid-Pacific) and inshore fishing areas.

Cannery Receipts of Domestically Caught Albacore

With relatively tight supplies of albacore worldwide putting upward pressure on ex-vessel prices and with favorable environmental conditions following the 1982-83 El Niño episode, prospects for the 1984 U.S. albacore fishery appeared to be a continuation of the upswing which began in 1983 (Squire, 1983). Only the announcement by Hawaiian Tuna Packers that it would not buy albacore at its Honolulu plant dimmed this outlook. However, Hawaiian Tuna Packers later retracted and agreed to purchase 400 tons of albacore from fishermen who had delivered to the cannery in the past. The uncertainty surrounding purchases of albacore by Hawaiian Tuna Packers deterred a large number of U.S. vessels from fishing in the mid-Pacific area early in 1984. About 30-40 vessels fished in the mid-Pacific during 1984, down 45 percent from 1983, and cannery deliveries from this area were 18 percent below those for 1983.

The albacore catch in the inshore areas (east of long. 140°W) increased 19 percent above that for 1983. A significant occurrence in 1984 was the unusually large catch of albacore by purse seiners: 4,100 tons were caught 50-100 miles off San Diego, Calif., during July and August (Majors and Miller[4]). Not since the early 1960's have purse seiners contributed to annual landings of North Pacific albacore in this magnitude. Troll gear (jig boats) is the dominant gear in the U.S. fishery.

Deliveries of domestically caught albacore to U.S. canneries totaled 13,888 tons in 1984, up 32 percent from 1983 and 42 percent above the 1979-83 average. This significant increase in receipts of domestically caught albacore can be largely attributed to highly propitious economic and environmental conditions. In addition, 108 tons of U.S.-caught albacore were exported in 1984, whereas no albacore was exported in 1983 (Table 2).

With production decreasing 15 percent and consumption increasing 17 percent during 1983, the U.S. white meat tuna supply entering 1984 was at a relatively low level. Consequently, fishermen were able to negotiate an early season ex-vessel contract price of $1,400 per ton for albacore ≥9 pounds, and $1,125 per ton for fish <9 pounds, increases of 12 and 15 percent, respectively, over the 1983 prices. Accompanying the increase in ex-vessel prices was a

[4]Majors, A. P., and F. Miller. 1985. Summary of the 1984 North Pacific albacore fishery data. NMFS Southwest Fish. Cent., La Jolla, Calif. SWFC Admin. Rep. LJ-85-14, 14 p.

Table 3.—U.S. cannery ex-vessel (contract) prices (dollars per short ton) at California and Puerto Rico, 1979-84.

Year	Albacore			Skipjack tuna				Yellowfin tuna				
	>18 lbs.	9-18 lbs.	<9 lbs.	>7.5 lbs.	4-7.5 lbs.	3-4 lbs.	<3 lbs.	Greater than 20 lbs.	7.5-20 lbs.	4-7.5 lbs.	3-4 lbs.	<3 lbs.
1979				$740-790	$740-790	$590	$400	$840	$840	$700-790	$700-790	$700-790
	$1,390	$1,320	$1,320	740-760	740-760	590-610	400-420	850-860	850-860	700-720	700-720	700-720
				760-805	760-805	610-655	420-505	860-905	860-905	720-765	720-765	720-765
	1,390	1,390	1,390	805-850	805-850	655-700	505-545	905-950	905-950	765-810	765-810	765-810
				850	850	700	545	950	950	810	810	810
1980	1,610	1,610	1,610	850	850	700	545	950	950	810	810	810
	1,635	1,635	1,635	1,100	1,100	1,000	800	1,200	1,200	1,100	1,100	1,100
1981	1,800	1,800	1,800	1,100	1,100	1,000	800	1,200	1,200	1,100	1,100	1,100
1982	1,425	1,425	1,425	1,100	1,100	1,000	800	1,200	1,200	1,100	1,100	1,100
				1,040	1,040	940	740	1,140	1,140	1,040	1,040	1,040
	1,350	1,225	1,000	890	890	700	500	1,170	1,050	890	890	890
1983[1]				950	850	700	420	1,230	1,050	850	700	420
	1,250	1,250	975	900	800	640	420	1,125	990	800	640	400
				880	780	585	250	1,125	975	780	585	250
1984[1]	1,400	1,400	1,125	830	730	500	250	1,085	950	730	500	250
				850	750	550	250	1,000	900	750	550	250
	1,150	1,150	875									
	-1,300	-1,300	-1,025	763	650	470	235	925	800	650	470	235

[1]Skipjack and yellowfin prices are for standard grade, prices may vary due to quality.
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

return to normal water temperatures, well developed temperature fronts, and good upwelling. These conditions were highly conducive to albacore fishing as evidenced by the exceptional purse seine catches from the inshore areas early in the season (Majors and Miller[4]).

However, by mid-season, following the unprecedented purse seine catches, ex-vessel prices dipped to $1,150 per ton for large fish and $875 per ton for small fish. Prices recovered somewhat after the influx of purse seine caught albacore, closing the season at $1,300 per ton for large fish and $1,025 per ton for small fish, still 4 and 5 percent, respectively, ahead of 1983 prices (Table 3).

Cannery receipts from the 1984 fishery generated more than $17 million in ex-vessel revenue, up 31 percent from 1983. Dividing 1984 ex-vessel albacore revenue by total U.S. cannery deliveries yields a weighted ex-vessel price of $1,252 per ton, down 1 percent from 1983, the lowest it has been in the past five years (Table 4).

Table 4.—U.S. cannery ex-vessel (weighted) prices (dollars per short ton), 1979-84.

Year	Albacore		Skipjack tuna		Yellowfin tuna	
	Nominal	Real[1]	Nominal	Real[1]	Nominal	Real[1]
1979	1,286	787	728	445	863	528
1980	1,659	930	1,063	596	1,180	661
1981	1,800	920	1,030	527	1,170	598
1982	1,387	669	965	465	1,123	542
1983	1,268	589	799	371	1,032	479
1984	1,252	560	760	340	982	440

[1]Adjusted for inflation using GNP implicit price deflator (1972 = 100).
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

Canned Albacore Production

At the beginning of 1984, the major U.S. tuna receiving and processing sites were San Diego and Terminal Island, Calif., Mayaguez and Ponce, Puerto Rico; Honolulu, Hawaii; and Pago Pago, American Samoa. With the closure of the Van Camp cannery in San Diego in mid-1984, which left only two California canneries in operation, tuna receipts and production data could no longer be reported separately for California without violating confidentiality requirements. Hence, California receipts and production data were combined with those from American Samoa and Hawaii (ASCH) for reporting purposes. Similar data for Puerto Rico are reported separately.

Of the total amount of raw (whole and other than whole) albacore supplied to canneries in 1984 (106,732 tons), 70 percent was delivered to canneries in Puerto Rico and the balance to canneries in ASCH. This resulted in a 49 percent increase from 1983 in albacore deliveries to Puerto Rico and a 2 percent decline in deliveries to ASCH. Seventy-five percent of the 1984 domestically caught albacore, or 10,323 tons, was received by ASCH canneries and the remainder, 3,565 tons, was transshipped to canneries in Puerto Rico from west coast ports (Table 2). This is a 1 percent decrease from 1983 in domestically caught albacore deliveries to ASCH. In 1983, only 4 tons of domestically caught albacore were received in Puerto Rico.

U.S. canneries received 92,844 tons of imported raw albacore in 1984, up 27 percent from 1983 (Table 2). Imports made up 87 percent of the total 1984 cannery supply of albacore, the same as in 1983. Puerto Rico was the major receiving site for imports with 70,882 tons or 76 percent of total albacore imports. ASCH received the rest. Albacore imports received in Puerto Rico during 1984 increased 41 percent from 1983, while imports received in ASCH decreased 3 percent. The leading exporter of raw albacore to U.S. canneries in 1984 was the Canary Islands,

Table 5.—Cannery imports of frozen tuna (short tons) by country of origin, 1979-84.

Source[1]	1979		1980		1981		1982		1983		1984	
	White	Light[2]	White	Light	White	Light	White	Light	White	Light	White	Light
Brazil		1,002	109	5,847	83	5,968	1,443	16,181	1,185	15,154	2,018	7,743
Canary Island	1,939	1,116	362		325		1,693	1	7,653	5	14,030	10
Cayman Island						2,171		6,723				9,960
Eduador		16,132	340	10,661						2,809		12,034
Ghana	215	41,102	70	30,071	760	36,188	1,078	27,783	345	23,751	170	6,640
Ivory Coast	162	10,141		12,860	345	35,805		27,862		13,783	289	30,997
Japan	7,310	10,694	3,957	45,112	6,483	12,307	5,834	12,705	696	18,426	10,946	20,965
Mauritius	6,038		4,349		1,364	152	4,811		4,668		5,026	
Netherlands Antilles	5,737	3,984	6,611	4,869	6,202	273	10,054	1,996	8,560	258	9,619	298
Panama		32,460		27,660		23,746		29,558	1	8,110	424	13,928
Philippines	60	27,210	37	26,799		20,781		5,923		6,476		1,327
Reunion	7,118	79	9,209	157	4,738	204	12,036	146	7,438	3	4,363	67
Seychelles										3,042		8,257
Singapore	3,613	1,505	3,444	5,366	3,969	7,781	1,386	3,846	4,217	3,761	5,024	
Solomon Island		17,328	1,088	18,984		22,618		928		10,600		15,836
South Africa	13,818	75	14,136	263	15,091	1,832	17,044	1	7,304	239	11,856	1,478
South Korea	372	485	412	925	1,547	4,893	1,001	6,891	5,374	13,830	2,119	11,064
Taiwan	983	34		244	1,730	169	99	384	5,075	3,851	9,739	9,468
Uruguay	9,988	48	7,903	1,719	9,920	1,489	8,835	670	4,480	143	3,228	722
Venezuela	222	1,153		865	394	5,496		2,421	1	6,604		7,002
Other	29,364	97,842	31,784	90,702	34,346	89,724	29,285	35,209	15,858	42,795	13,993	18,807
Total	86,939	262,390	83,811	283,104	87,297	271,597	94,599	179,228	72,855	173,640	92,844	176,603

[1]Data reflects the origin of shipments and not necessarily the flag of the catcher vessel.
[2]Light meat includes bigeye, blackfin, bluefin, skipjack, and yellowfin tuna.
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

Spain[5], with 14,030 tons or 15 percent of the total imports. South Africa was next with 11,856 tons, 12 percent of the total (Table 5).

Raw albacore imports received at U.S. canneries in 1984 were valued at about $145 million, up 42 percent from 1983. Dividing this value by the corresponding volume results in a weighted average import price of $1,561 per ton for raw albacore in 1984, nearly 17 percent above that for 1983.

The Pacific Ocean provided 44 percent of the total cannery supply of raw albacore in 1984. The Atlantic and Indian Oceans followed with 42 percent and 14 percent, respectively, of the total supply, all imports. The supply of albacore from the Pacific Ocean, 46,775 tons, represented a 37 percent increase from 1983, and that from the Atlantic, 44,601 tons, was a 34 percent increase from 1983. The Indian Ocean was the only oceanic area for which a decrease in supply (11 percent) occurred in 1984 (Tables 6 and 7).

White meat tuna production in Puerto Rico amounted to 4.6 million standard cases in 1984, 70 percent of the total U.S. albacore pack, and a 35 percent increase from 1983. ASCH produced 2.0 million standard cases of white meat tuna in 1984, down 18 percent from 1983.

Wholesale list prices for U.S.-produced, nationally advertised brands of white meat tuna remained between $55.50 and $60.15 per standard case throughout 1984. With discounts, the actual selling price at wholesale was as low as $42.25 for a standard case, a 12 percent increase over 1983. Production of both nationally advertised and private label (advertised and private brands) white meat tuna was valued at $256 million in 1984, up 30 percent from 1983. Based on total white meat volume, the weighted average value of unit production during 1984 was $38.88 per standard case compared with $38.43 in 1983, a 4 percent increase.

Tropical Tuna Production

Although U.S. consumption of tropical or light meat tuna products increased during 1984, corresponding processing showed a slight decline. Consumption of canned, light meat tuna packed in water increased nearly 9 percent, and consumption of oil-packed, light meat tuna decreased 6 percent. This led to an overall increase in light meat consumption of approximately 3 percent in 1984, based on relative market shares. Cannery production of all light meat products totaled 24.5 million standard cases in 1984, a decrease of 1 percent from 1983 and from the 1979-83 average (Table 1). The total cannery supply of light meat tuna, 417,296 tons, also declined 1 percent from 1983 and was 7 percent below the 1979-83 average (Table 2). Prices at the ex-vessel, wholesale, and retail levels continued to decline during 1984.

Domestically Caught Tropical Tuna Cannery Receipts

The U.S.-flag tropical or light meat tuna fleet consisted of 145 vessels at the start of 1984: 125 purse seiners and 20 baitboats (pole-and-line gear). By the end of 1984, the fleet had declined to 130 vessels: 109 purse seiners and 21 baitboats, with a total carrying capacity of 113,269 tons, a 12 percent decrease from 1983. However, 29 of these vessels were listed as inactive, and 18 of the vessels were seiners of individual carrying capacities of 400 tons or more.

The fleet operated almost exclusive-

[5]The exporting country reflects origin of shipments and not necessarily the flag of the catcher vessel.

Table 6.—U.S. domestic tuna cannery receipts and direct exports[1] (short tons) by ocean of origin, 1979-84 (None from Indian Ocean).

Ocean	Albacore							Skipjack tuna						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
E. Atlantic	12	2	2	62			16	1,384	2,458	3,327	27	21		1,444
W. Atlantic		18	4		4		5	501	25	108		3	233	127
E. Pacific	6,914	7,690	13,954	5,099	9,434	13,409	8,618	83,944	101,344	74,116	59,264	40,181	22,067	71,770
W. Pacific	1,604	388	897	1,866	1,032	587	1,157	10,753	12,258	20,571	42,546	114,913	137,678	40,208
Subtotal	8,530	8,098	14,857	7,027	10,470	13,996	9,796	96,582	116,085	98,122	101,837	155,118	159,978	113,549

	Yellowfin tuna[2]							Total						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
E. Atlantic	2,396	1,898	1,966	1,087			1,470	3,792	4,358	5,295	1,176	21		2,930
W. Atlantic	615	517	502	115	70	577	364	1,116	560	614	115	77	810	496
E. Pacific	142,667	116,947	110,251	96,640	65,863	59,823	106,474	233,525	225,981	198,321	161,003	115,478	95,299	186,862
W. Pacific	658	1,193	14,534	24,290	54,701	49,777	19,075	13,015	13,839	36,002	68,702	170,646	188,042	60,440
Subtotal	146,336	120,555	127,253	122,132	120,634	110,177	127,383	251,448	244,738	240,232	230,996	286,222	284,151	250,728

[1]Includes tuna landed directly or transshipped to a foreign country; excludes tuna exported from the east coast.
[2]Includes bigeye, blackfin, and bluefin tuna.
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

Table 7.—U.S. imported tuna cannery receipts[1] (short tons) by ocean of origin, 1979-84.

Ocean	Albacore							Skipjack tuna						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
E. Atlantic	16,843	14,567	17,105	19,815	16,935	27,392	17,053	50,218	40,318	67,011	49,417	34,358	35,882	48,265
W. Atlantic	20,352	15,016	16,894	21,129	16,127	17,209	17,904	3,211	6,546	8,754	17,119	18,070	9,059	10,740
E. Pacific	20	418	22	48	243	439	150	40,015	23,981	9,409	11,916	4,501	9,245	17,964
W. Pacific	32,955	36,808	43,638	35,375	23,226	32,340	34,400	93,837	132,283	95,119	44,017	72,742	72,699	87,600
Indian	16,769	17,002	9,638	18,232	16,324	15,464	15,593	1,289	5,503	7,716	5,546	5,637	7,988	5,138
Subtotal	86,939	83,811	87,297	94,599	72,855	92,844	85,100	188,570	208,631	188,009	128,015	135,308	134,873	169,707

	Yellowfin tuna[2]							Total						
	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$	1979	1980	1981	1982	1983	1984	79-83 $\bar{x}$
E. Atlantic	6,588	6,589	19,561	9,320	4,618	3,258	9,335	73,649	61,474	103,677	78,552	55,911	66,532	74,653
W. Atlantic	2,119	2,194	5,200	3,058	6,446	3,259	3,803	25,682	23,756	30,838	41,306	40,644	29,527	32,447
E. Pacific	39,637	30,891	16,039	19,200	7,492	9,222	22,652	79,672	55,290	25,470	31,164	12,236	18,906	40,766
W. Pacific	24,997	34,060	41,340	18,800	18,814	23,799	27,602	151,789	203,151	180,097	98,192	114,781	128,838	149,602
Indian	479	739	1,448	835	962	2,192	893	18,537	23,244	18,802	24,613	22,923	25,644	21,624
Subtotal	73,820	74,473	83,588	51,213	38,332	41,730	64,285	349,329	366,915	358,894	273,827	246,495	269,447	319,092

[1]Includes only imported tuna destined for canning; excludes tuna imported as flakes, tuna not fit for human consumption, and "sushi" grade tuna.
[2]Includes bigeye, blackfin, and bluefin tuna.
Source: Industry Analysis and Information Section, Southwest Region, NMFS, NOAA.

ly in the Pacific Ocean during 1984. Vessels active in the western Pacific numbered 61 at the beginning of 1984, with a combined carrying capacity of 72,562 tons. The number in the western Pacific declined to 43 at the end of 1984 with a capacity of 52,245 tons, a 28 percent decrease in both number and total capacity. Thirty-seven vessels, with a total carrying capacity of 25,150 tons, operated in the eastern Pacific during the first quarter of 1984 increasing to 58 vessels with a capacity of 39,623 tons by the end of the year, an increase of 57 percent in both number of vessels and capacity. Only four U.S.-flag vessels, having a combined capacity of 4,780 tons, fished in the Caribbean area of the Atlantic Ocean during 1984.

Cannery receipts of domestically caught, light meat tuna totaled 240,693 tons in 1984, 13 percent below 1983. This total comprised 145,593 tons of skipjack tuna and 95,100 tons of yellowfin tuna (includes bigeye, bluefin, and blackfin tuna), decreases from 1983 of 6 percent and 21 percent, respectively. In addition to deliveries to U.S. canneries, the U.S.-flag vessels exported 29,462 tons to foreign canneries, com-

pared with 583 tons in 1983. Total exports consisted of 14,385 tons of skipjack and 15,077 tons of yellowfin tuna (Table 2).

Ex-vessel prices for light meat which declined in 1983, fell further in 1984 (Table 3). The contract ex-vessel price (without quality adjustments[6]) for skipjack tuna in the 3- to 4-pound range was $470 per ton at the end of 1984, 20 percent below that at the close of 1983. The contract ex-vessel price for yellowfin tuna in the 7.5- to 20-pound range (without quality adjustments[6]) at the end of 1984 was $800 per ton, 18 percent below the corresponding price at the end of 1983. The reported ex-vessel value of domestically caught skipjack tuna receipts was $110 million in 1984, an 11 percent decrease from 1983. This yields a weighted ex-vessel price of $760 per ton, down 5 percent from 1983 (Table 4). Domestic deliveries of yellowfin tuna generated about $93 million in ex-vessel revenue for 1984, 25 percent below 1983. The weighted ex-vessel price for yellowfin tuna in 1984 was $982 per ton, also down 5 percent from 1983 (Table 4). Total ex-vessel revenue was about $203 million in 1984, an 18 percent decrease from 1983.

Canned Tropical Tuna Production

Skipjack, yellowfin, bigeye, and bluefin tunas are canned as light meat in the United States. The 6.5-ounce can of chunk style, light meat tuna in water was the most popular tuna product consumed in the United States during 1984, accounting for over 45 percent of all tuna sales.

The total supply of raw, light meat tuna, 417,296 tons, was delivered to canneries in Puerto Rico, American Samoa, Hawaii, and California during 1984. Puerto Rico was the leading receiving site in 1984 with 221,815 tons, 53 percent of the total U.S. cannery supply. The balance, 195,481 tons, was received at canneries in ASCH. Total receipts for Puerto Rico increased 23 percent from 1983, and decreased 27 percent for ASCH (Table 2). This reflects the diversion of deliveries to Puerto Rico due to the cannery closures in California.

Of the total receipts of domestically caught light meat tuna for 1984, 154,059 tons (64 percent) were received in ASCH, and the remainder, 86,634 tons, went to Puerto Rico. Again, the cannery closures on the U.S. west coast were a major factor contributing to the 25 percent decrease from 1983 in deliveries of domestically caught, light meat tuna to ASCH, and the 21 percent increase in deliveries to Puerto Rico (Table 2).

Light meat imports totaled 176,603 tons in 1984, almost 2 percent ahead of 1983. Imports made up 42 percent of the total cannery supply in 1984 versus 39 percent in 1983. Puerto Rico was the major receiving site for imports during 1984 with 135,181 tons (77 percent of the total), a 24 percent increase from 1983 (Table 2).

Skipjack tuna dominated imports in 1984 with 134,873 tons making up 76 percent of the total imports. Yellowfin tuna contributed the balance. Overall, skipjack tuna imports were down less than 1 percent from 1983, while yellowfin imports increased 9 percent (Table 2).

The top exporter of raw light meat tuna to the United States in 1984 was the Ivory Coast, with 30,997 tons or 18 percent of the 1984 total. Japan followed with 20,965 tons, 12 percent of the total (Table 5).

The total value of imports received at U.S. canneries in 1984 was $137 million, down less than 1 percent from 1983. The value of skipjack tuna imports was about $95 million, and the value of yellowfin tuna imports was about $42 million, a decrease from 1983 of 5 percent for skipjack tuna and an increase of 4 percent for yellowfin tuna. These values convert to weighted average prices of $704 per ton for imported skipjack tuna and $1,009 per ton for imported yellowfin tuna, a decrease from 1983 of 5 percent and an increase of 3 percent, respectively.

The Pacific Ocean was the primary source of all (domestically caught plus imports) U.S. cannery receipts of light meat tuna and domestically caught, light meat tuna exports to foreign canneries which together totaled 446,758 tons in 1984. The Pacific provided 384,300 tons or 86 percent of this total, the Atlantic Ocean 12 percent, and the Indian Ocean 2 percent, virtually all imports. On a regional basis, the western Pacific was the leading production area with 283,953 tons, 64 percent of total receipts and exports, an increase of 8 percent from 1983. Of the total receipts originating in the western Pacific during 1984, 66 percent (187,455 tons which includes U.S. exports) was domestically caught, and the remainder (96,498 tons) consisted of imports. Skipjack tuna was the predominant species in the western Pacific receipts and U.S. exports. Other oceanic regions contributing to the 1984 U.S. cannery supply and U.S. raw exports, in order of importance, were the eastern Pacific (primarily domestically caught yellowfin tuna), the eastern Atlantic (almost all skipjack tuna imports), and the western Atlantic (mainly skipjack tuna imports). A breakdown of the 1984 cannery supply and U.S. exports by ocean of origin is given in Tables 6 and 7.

Puerto Rico was the leading U.S. processing center for canned light meat tuna during 1984 with 12.6 million standard cases, 52 percent of the total light meat pack for 1984. This is an increase of 26 percent from 1983. The remaining 11.8 million standard cases were processed at canneries in ASCH, which is a decrease of 7 percent from 1983.

The wholesale list price of U.S.-produced, advertised, light meat tuna remained steady at between $40.05 and $40.64 per standard case, but it was discounted to $36.00 per standard case at the beginning of 1984 and declined to $32.00 by the end of the year, an 11 percent decrease. Total production of canned light meat tuna in 1984, both advertised and private label brands, was valued at $616 million, down 7 percent from 1983. Dividing total value by total volume yields a weighted average unit production price of $25.91 for a standard case of light meat tuna in 1984, 6 percent below that for 1983.

Canned Tuna Imports

The U.S. tariff on imports of canned tuna packed in oil is different from that

[6]Contract prices may be adjusted for salt content, unloading temperature, and condition of the fish.

on imports of canned tuna not packed in oil. Tuna in oil is subject to a 35 percent tariff; thus, imports are negligible. Canned tuna not in oil is under a tariff rate quota which allows imports up to 20 percent of the previous year's domestic production, excluding production at American Samoa, to enter at 6 percent ad valorem, and imports above the quota level enter at 12.5 percent ad valorem. Before the quota on canned imports not in oil is reached, the Bureau of the Census reports statistics on white meat and light meat imports separately. However, once the quota is reached Bureau of the Census records are combined for white and light meat imports so that a distinction between the two no longer exists. Therefore, year-end figures represent imports of both canned light and white meat not in oil.

The 1984 quota on canned imports not in oil was 95,587,400 pounds or about 4.9 million standard cases. Total imports reached a record 162.3 million pounds or 8.3 million standard cases, an increase of 33 percent from 1983. When the 1984 quota was initially reached on 16 July, white meat made up 13 percent of the imports of canned tuna not in oil. Imports of canned tuna in oil, practically all light meat tuna, totaled 277,000 pounds or about 14,000 standard cases, an increase of 40 percent from 1983.

Thailand exported the most canned tuna to the U.S. in 1984—89.7 million pounds or 4.6 million standard cases. This was 55 percent of the total and represents a 127 percent increase in imports of canned tuna from Thailand over 1983. Japan was a distant second with 26.9 million pounds or 1.4 million standard cases, 17 percent of the 1984 total.

Imports in 1984 were valued at about $167 million free on board, an increase of 22 percent from 1983. This converts to a weighted average price of $1.03 per pound or $20.09 per standard case which is 8 percent below that for 1983. Imports of canned tuna and their corresponding value by major exporting country are shown in Table 8.

Table 8.—U.S. imports for consumption by principal sources tuna in airtight containers (oil and water), 1979-1984.

Source	1979	1980	1981	1982	1983	1984
Quantity (1,000 pounds)						
Japan	28,366	24,794	21,271	26,481	20,387	26,855
Philippines	6,998	13,777	21,451	27,631	32,018	22,225
Thailand	4,844	6,405	10,315	18,667	39,930	89,685
Taiwan	12,282	15,947	15,771	10,704	18,710	17,935
Australia			58	1,930	2,799	
Malaysia	292	66	696	755	3,083	1,608
Indonesia			146	595	2,634	2,222
Maldives	62	600	592	327		
Spain[1]	336	146	170	120	133	214
Singapore		28	65	120	329	58
Other	523	1,792	316	248	2,306	1,511
Total	53,704	63,553	70,852	87,579	122,329	162,313
Value ($1,000)						
Japan	37,055	42,015	36,453	38,561	24,643	29,186
Philippines	7,319	20,043	30,504	31,085	32,291	20,396
Thailand	5,135	8,875	15,400	22,711	43,259	89,253
Taiwan	14,103	23,316	24,631	14,366	22,772	22,475
Australia			105	3,451	3,684	
Malaysia	314	76	1,230	1,242	4,068	1,893
Indonesia			209	699	2,679	2,102
Maldives	67	825	874	379		
Spain[1]	501	367	402	300	268	376
Singapore		38	91	141	386	44
Other	579	1,698	459	412	3,274	1,545
Total	65,071	97,254	110,358	113,347	137,324	167,270
Unit value ($ per pound)						
Japan	$1.31	$1.69	$1.71	$1.46	$1.20	$1.09
Philippines	1.05	1.45	1.42	1.12	1.00	0.92
Thailand	1.06	1.39	1.49	1.22	1.08	1.00
Taiwan	1.15	1.46	1.56	1.34	1.21	1.26
Australia			1.80	1.79	1.31	
Malaysia	1.08	1.14	1.77	1.64	1.31	1.18
Indonesia			1.43	1.18	1.01	0.95
Maldives	1.07	1.38	1.48	1.16		
Spain[1]	1.49	2.52	2.36	2.50	2.01	1.76
Singapore		1.38	1.41	1.17	1.17	0.76
Other	1.11	0.95	1.45	1.66	1.41	1.03
Average	1.21	1.53	1.56	1.29	1.12	1.03
Percentage of total quantity						
Japan	53	39	30	30	17	17
Philippines	13	22	30	32	26	15
Thailand	9	10	15	21	33	55
Taiwan	23	25	22	12	15	11
Australia			*[2]	2	2	
Malaysia	*	*	1	1	2	1
Indonesia			*	1	2	1
Maldives	*	1	1	*		
Spain[1]	1	*	*	*	*	*
Singapore		*	*	*	*	*
Other	1	3	1	1	3	1
Total	100	100	100	100	100	100

[1]Mainly oil packed.
[2]An asterisk means less than 1 percent, included in "Other" listing.
Source: Department of Commerce, Bureau of the Census computerized data files, 1979-84.

U.S. Consumption of Canned Tuna

Per capita U.S. consumption of canned tuna products for 1984 (excluding consumption by military personnel) was estimated at 3.2 pounds, 3 percent above 1983. If it is assumed that during 1984 canned light and canned white meat tuna were consumed in the same proportions that they were produced in the U.S. (21 percent white meat, 79 percent light meat), per capita domestic consumption would be about 0.67 pounds of white meat tuna and 2.53 pounds of light meat tuna. This converts to 1.5 standard cans of white meat tuna and 6.2 standard cans of light meat tuna per capita. Compared with 1983, per capita consumption of white meat tuna increased 24 percent in 1984 and increased 3 percent for light meat tuna. Based on the National Marine Fisheries Service's "Operation Price Watch" (USDOC, 1983, 1984), which monitors

the average price for domestically produced canned tuna in 10 U.S. cities, consumers paid an average of $1.47 per can for white meat tuna and $.86 per can for light meat tuna during 1984 (although retail promotions sometimes reduced light meat prices to $.59 per can), a decrease of 1 percent for both white and light meat from 1983. This results in a slight increase in estimated per capita expenditures on canned tuna in 1984—$7.54 versus $7.10 in 1983. These estimates are based on U.S. canned production and retail price information and do not take into account domestic consumption of imported canned tuna.

Discussion

Industry performance during 1984 was characterized by increased receipts of domestically caught albacore tuna, only a slight decrease in domestically caught tropical tuna destined for U.S. and foreign canneries, an increase in total domestic canned production, and continued growth in U.S. consumption of canned tuna products. This showing, however, offered little consolation to unemployed California cannery workers, purse seine crewmen, and vessel operators who lost their jobs when all but one major processor left the U.S. west coast.

Perhaps the most significant event affecting the U.S. tuna industry, or at least that which dominated the public's attention, was the industry's petition for a more equitable tariff on imports of canned tuna not in oil (in water) submitted to the International Trade Commission in early 1984. Citing rapid and substantial increases in import penetration that threatened to bring about significant liquidation of domestic tuna harvesting and processing capacity, the petitioners requested an increase in the rate of duty on canned tuna imports not in oil to 35 percent for 5 years. They reasoned that such an adjustment to the tariff on tuna canned in water, together with steps taken to reduce production costs, would restore profitability to the domestic industry, and thereby enable it to implement various long-term programs designed to enhance productivity and restore its ability to compete.

The rapid and substantial increase in the volume of canned tuna imports in water began in the early 1980's when tuna canned in water started to surpass tuna canned in oil in popularity among U.S. consumers, and rising production costs within the U.S. industry brought about record high prices at the ex-vessel, wholesale, and retail levels. This combination of events, plus a disparate tariff on tuna canned in water, provided an opportunity for lower priced, low-cost imports to inundate the domestic market. As a result, imports have made significant inroads into the strongest growing segments of the U.S. tuna market, that is, tuna packed in water for sale to private label and institutional customers. Since consumers of private label and institutional packs tend to purchase on the basis of price and not brand loyalty, these market sectors are characterized by extreme price sensitivity and very narrow profit margins. To maintain a presence in these sectors, domestic processors have had to accept greatly reduced prices for their institutional and private label packs.

Even though foreign processors have concentrated on the private label and institutional sectors of the domestic canned tuna market, sales of U.S. nationally advertised brands have also been affected. As rising costs of production pushed the price of domestically canned tuna higher, the widening price spread at retail induced consumers to substitute privately labeled imported tuna at much lower prices for the more familiar advertised brands. This situation precipitated major price reductions on nationally advertised brands. Together with depressed institutional and private label revenues, price reductions on the nationally advertised brands reduced profit margins to unacceptably low levels under the industry's existing operations structure.

To offset declining revenues, domestic processors acted to lower production costs by taking advantage of latent offshore production capacity. By shifting operations from the continental United States to sites in American Samoa and Puerto Rico, processors sought to realize significant savings associated with proximity to developing fishing grounds, lower labor costs, and economies resulting from consolidating operations.

While these adjustments led to acute unemployment at continental sites, the expanded offshore production increased employment at those sites making the overall industry unemployment situation appear less severe. Also, because income generated by processing operations in American Samoa and Puerto Rico is effectively exempted from U.S. tax, and because American Samoa and Puerto Rico grant tuna processors exemptions from local tax laws, there were additional incentives to concentrate production offshore. Moreover, the move to offshore processing was accompanied by accelerated development of the western Pacific fishing grounds which contributed greatly to a rapidly growing worldwide supply of cannery grade raw tuna. This allowed further cost savings on the part of U.S. processors by enabling them to withstand any increase in the price of raw fish, and in fact, ex-vessel prices continued to decline.

In the wake of these cost reducing measures, retail prices of domestically packed canned tuna began to decline and sales started to rebound. Nonetheless, prices of imports also declined, which renewed downward pressure on domestic prices. Thus, domestic processors continued to experience substantially lower profit margins which made it extremely difficult to justify long-term investments directed toward upgrading and expanding domestic production facilities. Consequently, a strong incentive for domestic processors to become prominent importers of canned tuna has been created.

The adversities that befell domestic processors in the early 1980's filtered down to U.S. tuna fishermen in the form of significantly lower ex-vessel tuna prices and increased difficulties and delays in landing and disposing of their catches. Furthermore, processors attempted to divest themselves of interests they held in tuna vessels and to reduce financial support they had provided to independently owned vessels. This occurred during a period of soaring interest rates that left many newer vessels, financed at variable interest rates, with unmanageable debt service.

Under these conditions many vessels in the fleet were unable to participate in the fishery, and the number of inactive vessels has increased dramatically since 1982. Yet in terms of the total receipts of domestically caught tuna and the number of active vessels, cannery deliveries on a per vessel basis have improved markedly since 1982. On the other hand, gross earnings per vessel, based on the total value of domestically caught tropical tuna receipts, have not improved. These circumstances reflect the abundant supply of tuna worldwide and the influence of international market conditions on U.S. ex-vessel price negotiations.

Deterioration of vertical integration within the industry and a weakening domestic ex-vessel market have prompted owners of U.S. vessels to look further abroad for alternative tuna fishing and marketing opportunities. This is exemplified by the growing number of foreign charters, the number of flag transfers, and unparalleled exports of domestically caught tropical tuna in 1984. Exports appear to represent a particularly significant opportunity, and the potential of exports has been enhanced by development of the western Pacific fishing grounds, the proximity of these grounds to east Asian processing sites, and also by improved fishing in the eastern tropical Pacific (ETP) in 1984. The preponderance of large yellowfin tuna (>20 pounds) in ETP catches has stimulated U.S. exports to European tuna markets where such fish command a premium price. This is in contrast to the east Asian markets where, due to relatively low labor costs, there is a greater demand for smaller, lower priced yellowfin and skipjack tuna, which are relatively abundant in nearby waters.

The impact of recent events on the U.S. tuna industry has not been confined to the tropical tuna fishery. Cannery closures and relocations have threatened U.S. albacore fishermen with the virtual disappearance of their traditional market. Given this prospect, those in the albacore sector of the industry have directed a great deal of attention and effort toward developing a restaurant and retail trade for fresh or fresh frozen albacore. Successful development of a fresh/frozen market for albacore will especially benefit small-boat fishermen who, by virtue of their vessels' limited operating range, are particularly vulnerable to U.S. west coast cannery closures. On the other hand, large-boat fishermen whose operating range is more extensive, are probably in a better position to service the realigned cannery demand.

Fresh tuna products may be a viable alternative for the tropical tuna fleet as well. Bluefin, bigeye, and yellowfin tuna, are usually available within relatively close range of major population centers on the west coast where there are growing markets for these popular, high-valued, "sushi" grade tuna species. Currently, these markets are being supplied by imports and, to a large extent, by shipments from the U.S. east coast and Hawaii. These circumstances seemingly present an opportunity for market penetration by U.S. west coast tuna fishermen, particularly small-boat operators who have been especially disadvantaged by the reduction in west coast processing capacity.

Acknowledgments

The authors wish to express their appreciation to the U.S. tuna industry for its continuing support. Its assistance through voluntary reporting of data made this report possible.

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Irradiation and Potassium Sorbate Compared as Preservation Treatments for Atlantic Cod, *Gadus morhua*

J. J. LICCIARDELLO, E. M. RAVESI, and D. L. D'ENTREMONT

ABSTRACT—Treatments of fresh Atlantic cod, Gadus morhua, *fillets with either 100 Krad gamma irradiation or a sorbate dip were found to be comparably effective in extending the iced storage life.*

Introduction

The use of ionizing radiation as an effective method for extending the refrigerated shelf life of fresh fish has been known for many years (Nickerson et al., 1954), and the subject has been covered in depth in a more recent review (Nickerson et al., 1983). However, the process is not yet being used commercially in this country for seafood applications pending approval by the U.S. Food and Drug Administration (FDA).

Various chemicals and preservatives, such as the nitrites, benzoates, and others, have been tested for their efficiency in preserving fresh fish (Tomisayu and Zenitani, 1957), but we are not aware of any being used commercially in this country. Probably the most effective of these preservatives tested, the tetracyclines (Torry Research Station, 1971), were disallowed by the FDA. A more recent generation preservative, sorbic acid or potassium sorbate, has been reported effective in extending the shelf life of fresh whole broilers (Robach, 1979), and it has also been found to be effective with certain seafoods (Debevere and Voets, 1972; Chung and Lee, 1981; Bremner and Statham, 1983; Shaw et al., 1983; and Ampola and Keller, 1985). This compound is on the GRAS (generally recognized as safe) list. Therefore, a comparison of the efficiency of these two seafood preservation methods (irradiation vs. sorbate treatment) may be useful for those fish processors who may not have access to an irradiation source or service, when the process is sanctioned for use.

Experimental Methods

Eviscerated, market-size Atlantic cod, *Gadus morhua*, of 1 day post mortem age were obtained from a Gloucester, Mass., "day boat." Two fillets were removed from each fish: One fillet was packaged in a Curlon S-660[1] (nylon-PVDC-surlyn) pouch and irradiated in the Marine Products Development irradiator (Cobalt 60) at the Gloucester Laboratory of the NMFS Northeast Fisheries Center to a maximum absorbed dose of 100 Krad (1 kGy) and the other fillet was dipped for 40 seconds in a 5 percent potassium sorbate solution, drained, and then packaged in a sealed pouch. Fillets to serve as control samples were taken from random fish of the same catch. Following the various treatments, the packaged samples were stored in flake ice in a walk-in refrigerator (2-5°C).

Sensory Analysis

Each fillet, after first removing a 50 g sample for bacterial analysis, was evaluated in the raw state for odor and in the cooked state for flavor and texture by a six-member panel comprised of the laboratory staff experienced in judging cod. Samples were scored on a scale ranging from 9 = excellent to 1 = inedible, and were considered unacceptable when the average score for an attribute fell below 5.5. For sensory evaluation of the cooked product, the fillets were flaced in a foil-covered pan and steamed (100°C) for 12-15 minutes. Each panelist was served an approximate 50 g portion.

Aerobic Plate Count

The aerobic plate count (APC) was made from appropriate sample dilutions onto pour plates of TPE agar (standard methods agar) reinforced with 0.5 percent Bacto peptone and 0.5 percent sodium chloride as recommended by Lee and Pfeifer (1974) for seafoods. Duplicate plates were incubated at 20°C and colony counts were made after 5 days.

DMA and TMA

Dimethylamine (DMA) and trimethylamine (TMA) analyses were performed by a gas chromatographic method (Lundstrom and Racicot, 1983). Results were reported as mg amine nitrogen/100 g.

Hypoxanthine

The enzymatic procedure described by Jones et al. (1964) was employed for determination of hypoxanthine content.

pH

A 20 g composite sample of muscle from various sections of the fillet was blended with 40 ml distilled water for 1 minute, and the pH of the slurry was measured with a Fisher Model 320 expanded scale pH meter. Skin surface pH

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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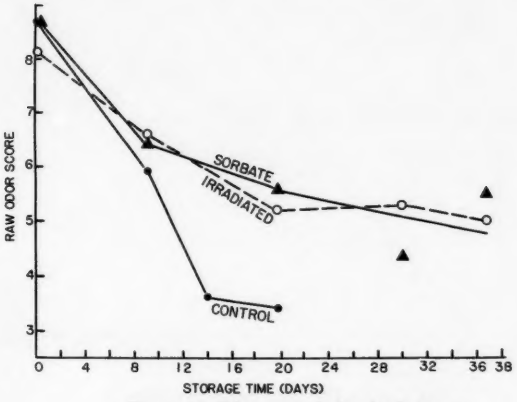

Figure 1.—Odor score during iced storage of Atlantic cod fillets.

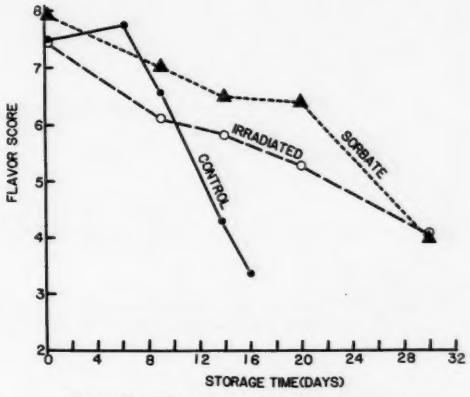

Figure 2.—Flavor score during iced storage of cod fillets.

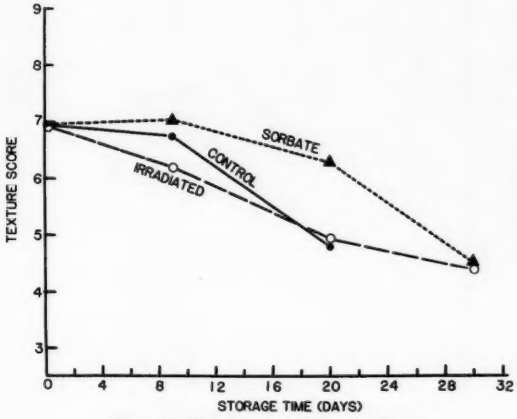

Figure 3.—Texture score during iced storage of cod fillets.

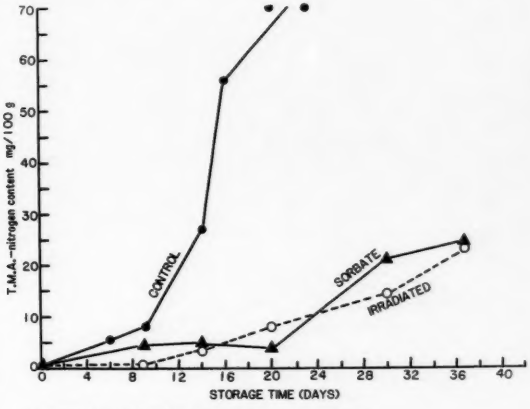

Figure 4.—Trimethylamine nitrogen content during iced storage of cod fillets.

was also monitored using an epoxy-body flat-surface combination electrode (No. 1208, Markson Science Inc.) in conjunction with a Fisher Accumet Model 230 pH meter. For equilibration, the electrode was submerged in ice water for 10-15 minutes prior to standardization with a pH 7 buffer at 1°C and, after use, rinsed with chilled distilled water.

Results and Discussion

The decline in odor score of the raw, variously-treated fillets during iced storage can be seen in Figure 1. Both the sorbate and irradiation treatments helped to preserve fresh odor and both treatments seemed comparable in this effect. The flavor score of the control samples also decreased at a faster rate during storage compared with the treated samples (Fig. 2). At any given test period, the sorbated fillets scored slightly higher in flavor compared with the irradiated samples, but this could have been due to a slight "irradiation" flavor in the irradiated samples and not to decomposition. Nevertheless, based on raw odor and cooked flavor scores, the controls were considered of marginal quality after 11 days, whereas the treated samples did not reach this stage until about 18-22 days. Texture deterioration during storage was considered comparable among all three treatments (Fig. 3).

Both the sorbate and irradiation treatments were effective in retarding trimethylamine formation in the fillets and both treatments were comparable in their effect (Fig. 4). From the graph, it is estimated that the TMA nitrogen content of the control at marginal quality

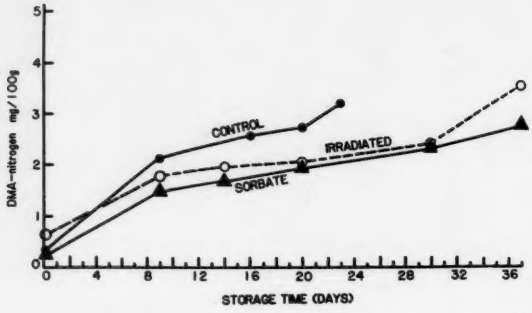

Figure 5.—Dimethylamine nitrogen content during iced storage of cod fillets.

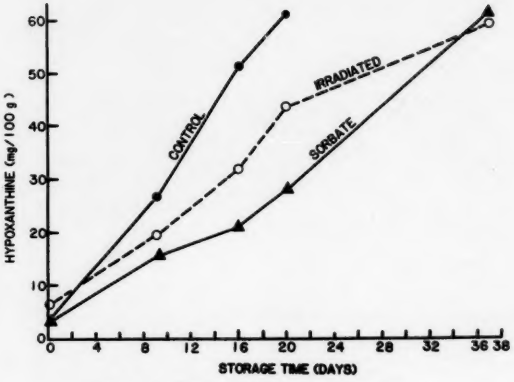

Figure 6.—Hypoxanthine content during iced storage of cod fillets.

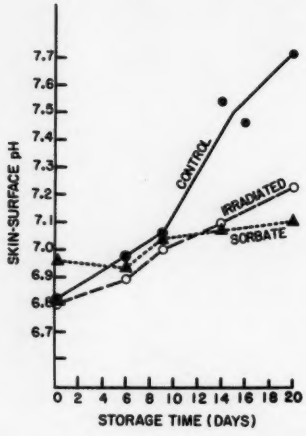

Figure 7.—Skin-surface pH during iced storage of cod fillets.

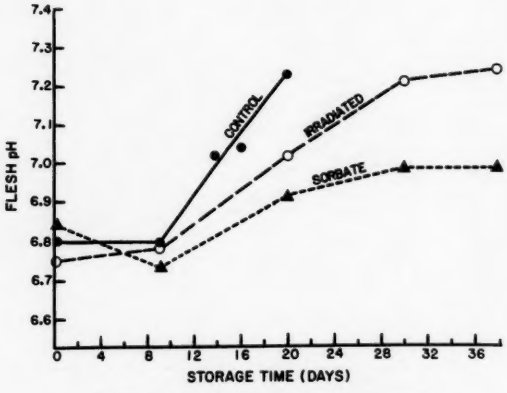

Figure 8.—Flesh pH during iced storage of cod fillets.

(11 days) was 15 mg/100 g. This value is in agreement with the value suggested by Dyer and Dyer (1949) for cod fillets.

The production of dimethylamine, another amine formed by bacterial action on fish (Dyer and Mounsey, 1945), was also less in the treated fillets compared to the control (Fig. 5) and there was no difference in rate of DMA formation between the irradiated and sorbate treatments.

Hypoxanthine, a product of post-mortem nucleotide degradation, increased steadily during storage among all treatments but at a faster rate in the control samples (Fig. 6). The rate of increase was about the same for the irradiated and sorbated samples. Hypoxanthine formation in fish during the early post-mortem period is thought to be due mainly to autolytic enzyme activity, and in the later storage periods bacterial activity plays a major role (Jones, 1965; Burt, 1976).

The change in pH during storage as measured both on the skin surface and a muscle homogenate can be seen in Figures 7 and 8, respectively. In general, there was much variability among individual fillets, but the results did show that after a delay of several days, the control sample increased more rapidly in pH compared with the two treatments, most probably due to microbial action and the production of amines. For the three different treatments, skin surface pH correlated well with flesh pH. Correlation coefficients ranged from 0.82 to 0.90. However, from linear regression analysis, we found that skin surface pH readings were about 0.1-0.2 pH units higher than flesh readings.

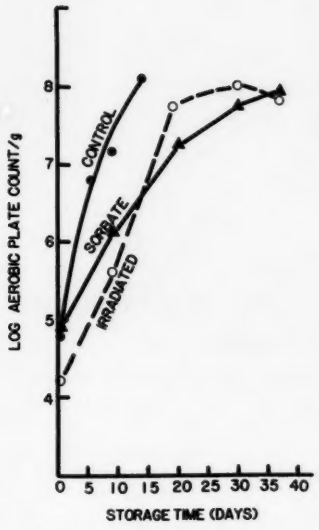

Figure 9.—Aerobic plate count during iced storage of cod fillets.

This was not attributed to the meter since the instrument was standardized at the beginning of the tests. Since aerobic bacterial growth is enhanced on air surfaces, there probably was a slightly greater concentration of alkaline metabolites on the skin. Nevertheless, surface pH measurement might be a simple, rapid method for assessing quality of fresh whole fish.

Total aerobic plate counts are presented in Figure 9. The counts increased most rapidly in the control samples, and at about the same rate in the irradiated and sorbated samples. The total plate count for the controls at time of marginal quality was estimated as 4 million per gram, whereas for treated samples the estimate was 10 million per gram. The higher spoilage count for the treated samples may have been indicative of a shift in flora to a less metabolically active type.

Conclusions

The two treatments studied (100 Krad ionizing irradiation, and a 5 percent potassium sorbate dip) were comparably effective in extending the iced storage life of fresh Atlantic cod fillets. However, the irradiation treatment does have certain advantages over the sorbate treatment. It avoids the use of a dip solution which has to be kept clean to avoid bacterial build up, has to be replenished to maintain constant concentration, and which requires a drain period prior to packaging. In addition, the irradiation process will inactivate certain pathogenic bacterial contaminants in addition to the spoilage types. However, for those without access to an irradiation facility or service, sorbate treatment could be useful for extending fresh shelf life of fish fillets.

Acknowledgment

The authors thank R. C. Lundstrom for the amine analyses.

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Microbiological Air Quality Assessment of Seafood Plants as Impacted by Solid Waste

DONN R. WARD and DEBRA J. O. HOPSON

ABSTRACT—Microbial populations (aerobic plate count, coliforms, and yeast and molds) in the air surrounding an oyster shell pile and a crab waste bin were periodically monitored to determine the relationship these populations had on the microbial populations observed inside the processing plants. Furthermore, environmental parameters such as temperature, relative humidity, wind speed, and wind direction were determined at the time of each sampling. Some relationships were observed between microbial populations in the air around the oyster shell pile and environmental factors to the airborne populations found inside the processing plant. No significant relationships were observed for the crab waste bins, this apparently due to frequent dumping and the use of lime. Although the contribution of airborne contamination from waste piles was shown to be comparatively small, the potential exists, and suggestions for mitigation are discussed.

Introduction

Crab and oyster processors often encounter periodic problems, especially during the summer months, with high bacteriological counts on their products. In the crab industry, excessive bacterial counts have often been attributed to such factors as crabs being spoiled prior to cooking, short cooking times, high proportion of egg bearing crabs, and temperature abuse of the product after cooking. However, in the oyster industry, the holding of shellstock at abuse temperatures prior to shucking has been shown to cause increases in total bacterial counts (Hood et al., 1983). Although any of these factors could potentially contribute to the problem, health department sanitarians have indicated that in some instances elevated bacterial counts on these products cannot reasonably be explained by any of the possibilities mentioned (Altman[1]).

Although airborne microbial contamination in food processing plants has been studied by other investigators (Kotula et al., 1978; Sunga et al., 1966; Heldman et al., 1966; and Sullivan, 1979), it has not been previously investigated in the seafood processing industry, particularly in reference to crab and oyster processing waste.

Crab and oyster processors have traditionally handled their waste by conveying it outside the plant and holding until disposal. Crab waste is usually removed once or twice a day depending on season; oyster shells, with proteinaceous material still adhering, may remain in shell piles for several days or perhaps weeks. Consequently, the possibility exists that these piles could serve as contaminant reservoirs if airborne particles carried bacterial contamination from the waste piles into the plant.

The objective of this study was to assess the influence of seafood waste disposal sites on the microbiological quality inside processing plants and the relationship certain environmental parameters may have to the process.

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Materials and Methods

Air Sampler

The air sampling device used in this project was a RCS Centrifugal Air Sampler[2] (Biotest Diagnostics Corp., Fairfield, N.J.). This device, either handheld or mounted on a tripod, has an impeller blade that pulls 20 L of air every 30 seconds into the impeller drum which contains an agar strip. The air, which enters the impeller drum concentrically and in a conical form, is set in rotation, and the particles contained in the air are impacted by centrifugal force onto the agar strip. The RCS sampler can be set to operate for 30 seconds, every 1, 2, 3, 4, or 8 minutes, depending on anticipated microbial loads.

Enumeration of Microorganisms

Microbial tests performed in this study were total aerobic count, coliform, and yeast and mold. These organisms were enumerated on trypticase soy agar (TSA), MacConkey's Agar (MA), and rose bengal agar (RBA), respectively. All agar strips were prepared and supplied by Biotest. TSA and MA strips were incubated at 35°C and enumerated at 48 hours, while RBA strips were also incubated at 35°C but enumerated at 120 hours.

Sampling at Shell Waste Piles

To accomplish the objective of this study, microbial air samples around the oyster shell waste pile (Fig. 1) and crab

[1]Altman, J. 1979. Virginia State Health Department, Bureau of Shellfish Sanitation, Norfolk, Ca. Personal commun.

[2]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

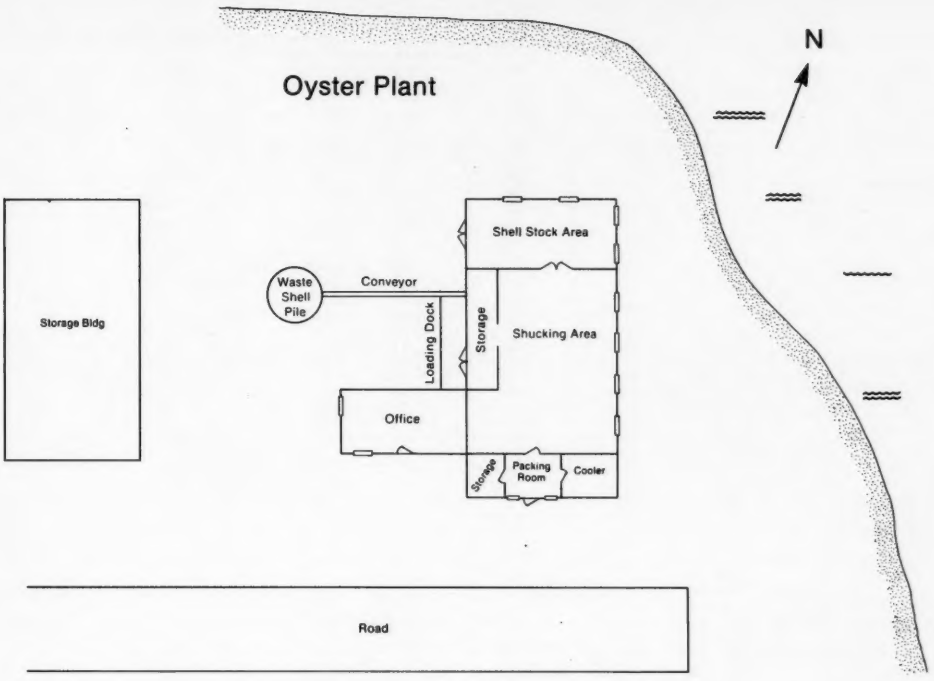
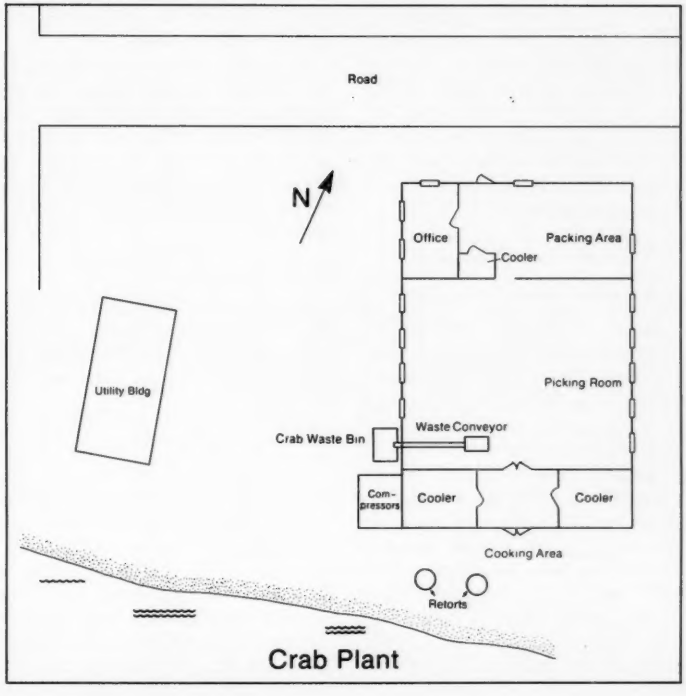


Figure 1.—Oyster plant layout and location of waste pile.

Figure 2.—Crab plant layout and location of waste bin.



waste bin (Fig. 2) were taken every 3-4 weeks for 1 year (1982-1983), except during the summer months (June, July, and August) when sampling was done every 1-2 weeks. Plants were located in the Tidewater region of Virginia.

Eight different sampling locations were selected around each waste site. Four sampling locations were selected at both 1 m and 8 m away from the waste piles. Once selected, sampling locations always remained the same. On each sampling day, duplicate samples were taken at each location with each sample taken 1 m above the ground. Additionally, duplicate air samples were also taken on each sampling day inside the plant. The inside location was selected such that it was nearest the point within the plant where contamination from the

piles would most likely gain entry, i.e., windows and doors. Figures 1 and 2 depict the location of the waste piles and general layout for the oyster plant and crab plant, respectively.

Other Measurements

In addition to monitoring the microbiological quality of the air, on each sampling day measurements were also taken of the temperature, relative humidity, wind velocity, and wind direction. Temperature and wind velocity were determined with a 100VT Air Velocity and Air Temperature Meter (Datametrics, Wilmington, Mass.). Relative humidity was measured with a sling psychrometer (Taylor Instrument Co., Rochester, N.Y.). Wind direction was determined by observing a small plastic ribbon attached to a tripod.

Table 1.—Meteorological conditions and number of organisms enumerated around oyster shell pile and inside oyster processing plant in 1983.

Month	RH[1]	Avg. wind speed[2]	WD[3]	Temp.[4]	Organisms/foot^3 of air					
					APC-I[5]	COL-I[6]	YM-I[7]	APC[8]	COL[8]	YM[8]
January	90	600	W	59	NT[9]	NT	NT	11.19	2.47	3.58
January	86	150	W	50	NT	NT	NT	11.37	4.15	4.02
February	94	130	E	51	4.25	NT	1.06	6.59	0.22	0.46
March	62	100	E	60	44.07	0.17	0.70	6.03	0.13	0.53
April	61	130	E	60	NT	NT	NT	30.62	0.26	5.41
May	78	30	E	65	16.10	1.94	6.90	8.31	0.19	4.77
June	77	100	W	85	233.64	0.17	1.77	47.23	2.63	7.39
June	92	125	SW	67	9.55	0.35	0.35	21.19	2.14	5.48
July	77	75	N	90	39.82	1.95	3.54	13.07	1.12	3.35
July	74	150	SE	89	15.22	1.06	5.42	16.69	1.28	5.54
July	63	50	E	94	NT	NT	NT	14.20	0.37	5.08
August	59	75	W	94	13.27	4.42	14.16	23.63	5.04	13.31
August	55	175	SW	85	310.10	3.00	15.04	44.80	4.21	12.74
September	71	75	E	84	NT	NT	NT	14.31	1.26	3.08
October	73	110	W	90	44.95	4.49	1.05	16.87	2.40	11.30
October	88	50	E	70	10.97	4.78	4.07	20.90	1.83	3.84
November	89	30	E	41	64.78	18.23	7.26	26.66	4.44	7.43
December	96	20	W	69	56.64	8.50	3.54	42.32	7.54	5.35
December	97	50	W	71	10.26	7.96	6.72	16.63	6.06	5.02

[1]Relative humidity.
[2]Average wind speed in feet/minute.
[3]Wind direction.
[4]Temperature (°F).
[5]Aerobic plate count inside plant.
[6]Coliforms inside plant.
[7]Yeast and molds inside plant.
[8]Outside data around oyster shell piles.
[9]NT = Not tested.

Statistics

Microbial data from the various locations around the piles were averaged and the relationship correlated between these counts and the microbial loads found in the plants. Stepwise regression analysis was performed on the total aerobic counts, coliforms, and yeast and molds inside the plant using the following independent variables: Relative humidity, average wind speed, temperature, wind direction, and outside total aerobic counts, coliforms, and yeast and molds. Additional analyses were performed after stepwise regression to determine significance.

Results and Discussion

Oyster Waste Data

The total aerobic counts (Table 1) obtained within the oyster plant had the highest correlation with the interaction of aerobic counts around the shell pile and wind speed ($r = 0.86$). In other words, as the aerobic counts in the air immediately around the shell pile increased and as the wind speed increased, a significant correlation was shown with increased aerobic counts of air within the plant. Other interactions with aerobic counts around the pile such as temperature, wind direction, and relative humidity, did not correlate with increased microbial counts of the air within the plant.

The interaction of total coliforms and wind direction around the pile correlated very highly with the total coliforms enumerated in the plant ($r = 0.91$). As would be expected, the correlation was most significant when the shell pile was directly between the plant and the prevailing wind direction.

Yeast and molds levels in the air inside the plant demonstrated its highest correlation with the interaction of yeast and molds around the pile and relative humidity ($r = 0.73$). Interestingly, the lower the outside relative humidity was, the higher the levels of yeast and molds were.

Crab Waste Data

Analysis of the data generated from the crab waste bins produced no significant correlations. Table 2 shows the data from around the waste bin and inside the plant.

Discussion

When this project was developed, we thought that the waste piles could potentially be a significant source of airborne bacterial contamination. However, results indicate that the waste may be no more a significant source than are plant workers. Heldman (1967) reported that the bacterial contributions from food-plant workers ranged from 20 to 70 bacteria per minute. Results from around the oyster shell pile suggests APC ranged from 6.03 to 47.23 organisms/foot^3, coliforms ranged from 0.13 to 5.04 organisms/foot^3, and yeast and molds ranged from 0.46 to 13.31 organisms/foot^3. Ranges from the crab waste bin for APC, coliforms, and yeast and molds were: 4.30-80.54, undetected-16.34, and 0.20-23.51, respectively. Certainly the numbers of organisms enumerated from around the waste areas do not appear to be high, and, as suggested, plant workers may in fact be a more significant source of airborne contamination.

Organisms enumerated from the air within the plants were not as high as anticipated. Ranges per cubic foot of air in the oyster plant for APC's, coliforms, and yeast and molds were 4.25-310.10, 0.17-18.23, and 0.35-15.04, respectively. In the crab plant these ranges were APC's 1.06-0.09, coliforms undetected-16.99, and yeast and molds undetected-14.16. Furthermore, these counts seemed very reasonable, especially when compared with counts reported by Zottola et al. (1970) for a turkey processing plant of total bacteria 10,000/10L (28,300/foot^3) and 10/10L (28/foot^3) for coliforms. Beaucourt et al. (1977) reported an average total count of 4/10L (11.32/foot^3) in a modern meat processing plant.

While the numbers of organisms asso-

Table 2.—Meteorological conditions and number of organisms enumerated around crab waste bin and inside crab processing plant.

Year and month	RH[1]	Avg. wind speed[2]	WD[3]	Temp.[4]	Organisms/foot[3] of air					
					APC-I[5]	COL-I[6]	YM-I[7]	APC[8]	COL[8]	YM[8]
1983										
January	100	450	N	42	9.73	0	0	12.62	0	0.53
January	80	50	S	56	1.06	0	2.12	4.30	0.05	1.56
February	91	120	S	60	14.87	0	0	11.38	0.59	2.24
February	85	150	N	49	44.07	0	0.71	5.57	0	0.53
March	61	70	SE	70	63.53	2.12	0.35	6.60	0.50	0.20
1982										
April	92	300	N	54	ND[9]	16.99	7.78	12.56	0.41	0.97
May	81	1500	N	82	21.22	0.88	3.71	21.07	0.35	5.33
May	67	30	S	76	13.23	0.35	0.70	27.95	3.44	7.01
June	67	140	SW	76	28.29	1.94	2.12	33.02	1.73	16.10
June	82	75	S	85	13.10	1.23	0.70	15.78	0.35	3.92
July	71	100	S	91	17.52	2.83	0.17	28.61	1.88	1.44
July	65	125	SE	91	40.35	1.41	0.88	24.95	1.12	5.60
July	56	150	S	89	61.06	4.53	0.70	13.92	0.91	3.23
July	65	100	N	81	12.03	0.53	1.41	80.54	16.34	8.93
July	66	175	S	89	31.81	0.17	3.01	22.82	1.56	11.56
August	63	150	NE	83	18.41	0.88	5.13	52.92	7.01	15.24
August	76	100	S	86	52.00	0.17	2.47	35.43	1.35	4.25
August	81	80	SW	71	16.95	0.88	1.76	14.76	1.41	4.71
August	55	150	N	90	50.44	7.08	7.43	55.48	3.55	23.51
September	72	200	N	80	27.79	1.77	5.48	23.54	8.34	11.03
September	73	275	N	72	70.09	1.06	0.88	8.96	1.47	2.50
September	71	75	S	78	38.76	9.38	3.18	19.05	1.35	5.45
October	75	70	SE	75	17.15	4.24	2.47	20.91	1.35	5.36
October	65	120	SW	75	14.16	0.53	5.31	25.31	5.42	4.48
November	67	170	S	70	23.19	2.47	7.43	21.32	5.31	7.19
November	90	150	N	74	42.12	7.43	14.16	43.18	4.21	8.25

[1]Relative humidity.
[2]Average wind speed in feet/minute.
[3]Wind direction.
[4]Temperature (°F).
[5]Aerobic plate count inside plant.
[6]Coliforms inside plant.
[7]Yeast and molds inside plant.
[8]Outside data around crab waste bin.
[9]ND = No data.

ciated with waste piles are not large, nonetheless, it is interesting to note the correlations that were observed between conditions outside the plant and bacteria numbers and types found inside the plant. First, it is not too surprising that significant correlations were not associated with the crab waste bins inasmuch as this waste is emptied from the bins at least once a day and twice daily during the summer. Furthermore, due to problems encountered with flies, it is a common practice to throw lime into the bins when emptied, especially during the summer months. The combination of frequent removal and high pH are no doubt important factors mitigating potential airborne contamination which could result from the waste.

Oyster shells, however, remain in piles around the plants for days and often weeks. Pieces of oyster meats are frequently found adhering to the shells, thus serving as a nutrient source for microbial proliferation. The data indicate that the interaction of aerobic plate counts around the pile and wind speed were significantly correlated with increased counts within the plants. Although this is precisely the type of interaction which was hypothesized at the beginning of the study, the numbers involved are low.

The high correlation of total coliforms around the oyster shell pile and wind direction, with the total coliforms enumerated in the plant is of interest. Coliforms and specific organisms within the coliform group are often used as indicators of sanitary quality. While the number of coliform organisms enumerated were low, the number of certain coliform organisms, such as *E. coli*, allowed on food products are also low. Although the coliforms enumerated in this study were in all likelihood of environmental origin, given the problems encountered by the oyster industry during the past few years, even these sources can cause regulatory problems (Hackney et al.[3]).

The relationship of yeast and molds to relative humidity demonstrated some degree of correlation ($r = 0.73$). The lower the humidity was, the more yeast and mold organisms were enumerated in the air. Although it is well documented that these organisms have a greater tolerance to dry conditions, the significance of this to the present finding is uncertain.

[3]Hackney, C., D. Sbaih, L. Reily, M. Kilgen, and M. Cole. 1983. Non-*E. coli* fecal coliforms in oysters. Paper presented at the Interstate Seafood Seminar, Ocean City, Md., 1-3 Nov.

Summary

Although, during this study, the contribution of airborne contamination from waste piles was demonstrated to be comparatively small, the potential for contamination exists. Therefore, it would be prudent to take precautions to limit airborne contamination from waste piles, or other potential sources. Such precautions could include: 1) Locate waste piles away from the immediate vicinity of doors and windows, 2) ventilation fans and air conditioners should not be sited near waste piles, and 3) empty waste bins as often as possible.

Acknowledgment

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Estimating Total Length of Headless White Hake, *Urophycis tenuis*, Landed in Maine

EDWIN P. CREASER and KERRY M. LYONS

Introduction

The white hake, *Urophycis tenuis*, occurs in continental waters between the Gulf of the St. Lawrence and the Middle Atlantic States from near the tide mark to a depth of about 545 fathoms (Bigelow and Schroeder, 1953). It supports a valuable commercial fishery in the Gulf of Maine and is abundant toward the mouth of the Bay of Fundy where it is landed by Nova Scotia, New Brunswick, and Maine fishermen. Historically, the center of abundance along the Maine coast occurs between Machias and Mt. Desert Island, in Frenchmen's Bay, and off Penobscot Bay (Fig. 1). Smaller concentrations occur outside the islands from Penobscot Bay to Cape Elizabeth and along the western side of the Gulf of Maine, especially near Boon Island, Isle of Shoals, Ipswich Bay, and the lower slopes of Jeffreys and Stellwagen Banks (Bigelow and Schroeder, 1953).

White hake landings dropped from 7.1 to 1.0 million pounds between 1948 and 1969. Since 1970, landings and landed value have increased to a high of 9.4 million pounds (1983) and $1,367,000 (1985), respectively.

Despite the importance of white hake as a commercial resource, little is known about the length composition of this species landed from Maine fishing vessels. This is because hake are frequently landed with the heads removed (Williams, 1967). This study was made by port sampling personnel of the Maine Department of Marine Resources to develop an easy and rapid method of determining total lengths of headless white hake at unloading sites.

ABSTRACT—Whole, assorted, white hake, Urophycis tenuis, *of commercial size were obtained from commercial fishermen at five geographical locations along the Maine coast. Measurements of total length from the tip of the snout to the end of the caudal fin (L_T), the distance between the anterior base of the first dorsal fin and the end of the caudal fin (L_D), the distance between the forward edge of the pectoral fin and the end of the caudal fin (L_P) and the distance from the anus to the end of the caudal fin (L_A), were obtained. Analysis of covariance on the linear relationships L_T:L_D, L_T:L_P, and L_T:L_A from each geographical location showed no significant differences and the data were combined. Slopes, y-intercepts, and correlation coefficients were calculated for geographically combined data and L_T:L_D was selected as the most satisfactory method for measuring headless white hake. The equation for this regression is $L_T = 1.328\ L_D - 0.041$.*

Fish measuring strips, constructed from polystyrene, were calibrated and marked in increments of 0.753 cm calculated from the above linear regression. Each increment of 0.753 cm was equivalent to 1 cm and was marked as such on the strip. Strips were inserted into a slot on a special measuring board, and an ice pick was positioned vertically at the 0 mark. Headless white hake from commercial vessels were placed on top of these strips and the fish were moved until the anterior base of the erected dorsal fin was positioned against the ice pick. The estimated total length of the fish was then read directly from the strip to the nearest cm.

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Materials and Methods

Assorted commercial-sized white hake used for this study were obtained from five geographical locations (Fig.

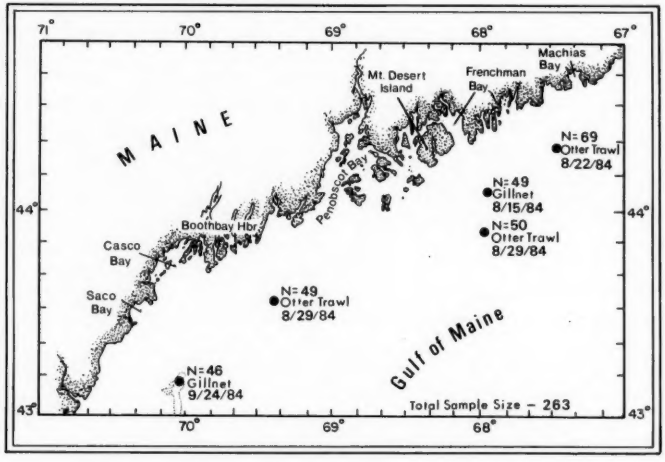

Figure 1.—Locations where whole white hake samples were obtained.

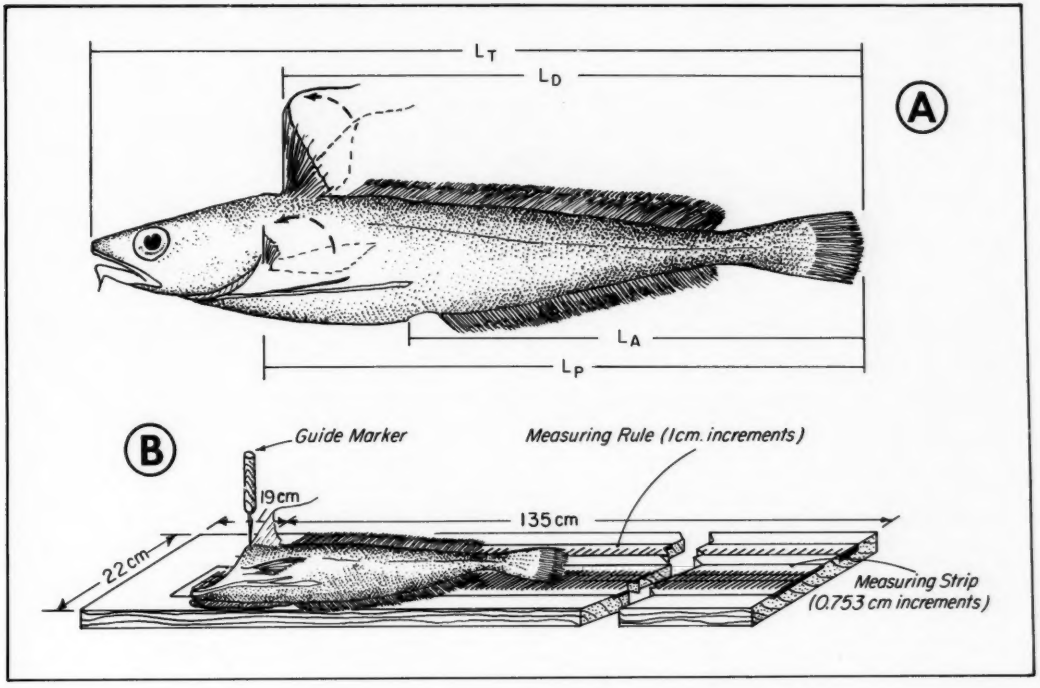

Figure 2.—The measuring procedure and board: A) Measurements obtained and B) construction and use of measuring board.

1) in August and September 1984 through prior arrangement with dragger and gillnet fishermen. Fish were gutted, cooled, and landed with the heads intact. Fish were obtained from commercial operations (as opposed to research tows) because it was desirable to duplicate the conditions the fish were subjected to prior to being landed commercially.

Species Identification

Species' identification was confirmed by three methods: Body length, the length of the third ray of the first dorsal fin, and the number of gillrakers on the epibranchial of the first gill arch. Confirmation was desirable because both white hake and red hake, *Urophycis chuss*, are sometimes encountered in the same tow.

The quickest and most obvious method of confirmation was based on length. Some white hake exceeded the maximum length of 72 cm (30 inches) reported for red hake (Bigelow and Schroeder, 1953), and identification was confirmed on this basis alone. The length of the filamentous portion of the third ray of the first dorsal fin was also used as an identification criterion. Bigelow and Schroeder (1953) reported that this ray is a little longer than the fin proper is high on white hake but it is 3-5 times longer on red hake (if undamaged).

The most reliable means of separating the two species in the field is by counting the gill rakers on the epibranchial of the first gill arch (Flescher, 1980; Musick, 1974). The white hake has two gill rakers and the red hake has three. Based upon these criteria, it is unlikely that there were any misidentifications of white hake.

Measurement and Data Analysis

Four measurements in millimeters were obtained from whole fish supplied by commercial fishermen (Fig. 2A). Total length (L_T) was recorded using a measuring board (with headstop) and the remaining three measurements—dorsal (L_D), pectoral (L_P), and anal (L_A)—were obtained using a modified board of similar dimensions but lacking a headstop. This board was constructed with a 19 cm platform to support the anterior portion of the fish. A guide marker (ice pick) was inserted vertically into a hole located at the 0 mark on the rule. The dorsal measurement (L_D), was obtained by holding the fin erect and sliding the fish along the board until the forward edge of the fin touched the guide marker (Figure 2B). The pectoral measurement (L_P) was

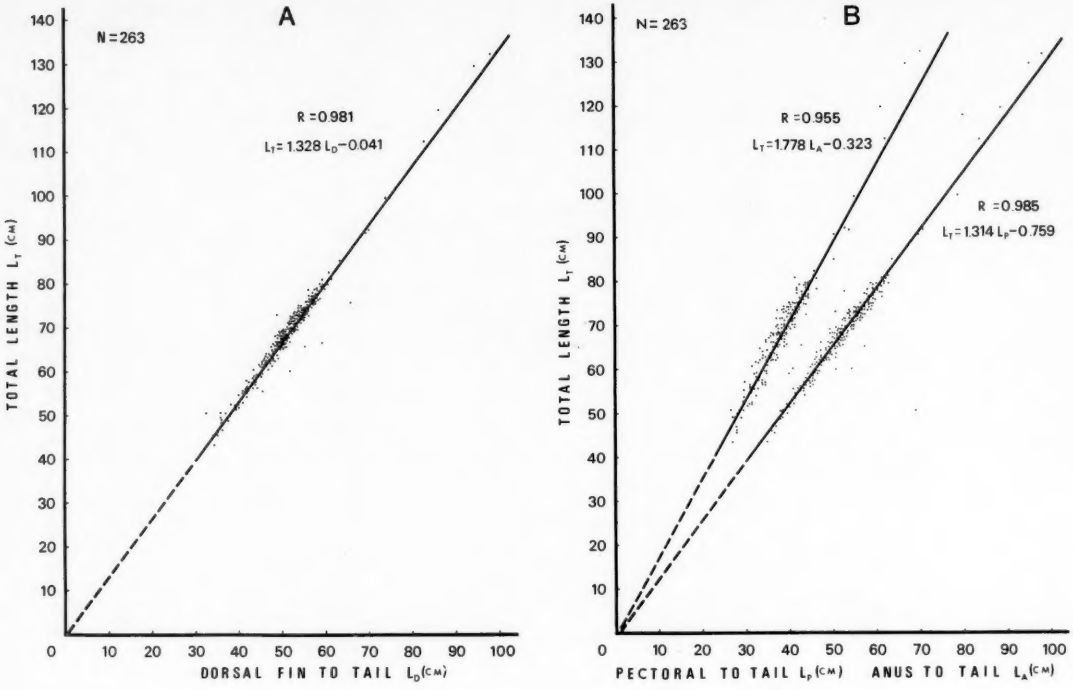

Figure 3.—Linear regressions for A) The relationship of L_T:L_D and B) the relationships of L_T:L_P and L_T:L_A.

obtained by lifting the pectoral fin so its anterior edge was parallel to, and directly in line with, the vertical guide marker. The anal measurement (L_A) was obtained by placing the anterior edge of the anus in contact with the guide marker. Analysis of covariance was performed on the linear relationship between L_T and the measurements L_D, L_P, and L_A on all fish from the five locations.

Results and Discussion

Statistical Analysis

No significant geographical differences were found when linear relationships between L_T and L_D, L_P, and L_A from the five geographical areas were tested by analysis of covariance, and the data were combined. These results suggest that white hake along the Maine coast may belong to one population. Our findings are consistent with those reported by Musick (1974), who combined New England and Nova Scotian white hake on the basis of morphometric analysis. Slopes, y-intercepts, and correlation coefficients were calculated for each set of combined measurements and the results are presented in Figure 3. The correlation coefficients for L_T:L_D, L_T:L_P, and L_T:L_A were 0.981, 0.985, and 0.955, respectively.

The total length to dorsal length relationship was chosen as the standard method for calculating white hake total lengths because: 1) Differences between correlation coefficients of 0.981 and 0.985 were negligible and 2) it was easier to measure the dorsal length. Williams (1967), in calculating total length of headless fish, incorrectly treated the predicted total length, L_T, as the independent variable and L_P and L_A as dependent variables. However, we have treated L_T as the dependent variable and L_D, L_P, and L_A as independent variables in calculating the linear regression lines. The resulting linear regression for L_T:L_D is:

$$L_T = 1.328\ L_D - 0.041. \quad (1)$$

Using equation (1) and solving for L_D, we find

$$L_D = 0.753\ L_T + 0.032.$$

The Measuring Strips

Measuring strips constructed from aluminum and laminated polystyrene are used extensively by National Marine Fisheries Service port samplers on both the east and west coasts. The modified measuring strips we developed are similar in design and calibration to those

used by Williams (1967), though the means to calculate them differed as noted.

We constructed fish measuring strips of polystyrene measuring 7.6 cm wide × 101.6 cm long × 1.6 mm thick. Numbers and calibration increments were applied using silk screening techniques.

Measuring strips were calibrated and marked in 0.753 cm increments (equivalent to 1 cm in total length) calculated from the linear relationship selected, L_T:L_D (Fig. 4). The first increment was half the width of the succeeding increments because lengths lumped within each centimeter grouping included measurements 0.5 cm below and 0.5 cm above that grouping (Schultz[1]).

The calibration also allowed total lengths to be rounded to the nearest centimeter. For instance, a fish measuring between 40.5 and 41.4 cm (L_T) would be read as 41 cm (L_T) on the strip. The y-intercept value (0.032) was not significantly different from 0 and was therefore ignored.

Calibrated measuring strips were inserted into the slot on the modified measuring board (lacking a headstop), and headless white hake were placed on the strip for measuring. A pencil mark (No. 1 pencil) was placed at the end of the caudal fin in the appropriate interval numbered to correspond to the total length of the fish. After measuring a sample of fish, pencil marks were easily removed with liquid or powdered detergents; thus, the strips were reuseable.

[1]Schultz, R. L. 1974. Manual for sampling, interviewing, and coding for the Northeast Region. U.S. Dep. Commer., NOAA, NMFS Stat. Market News Div., Gloucester, Mass., 144 p.

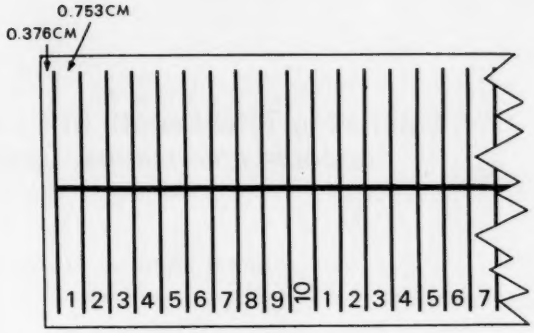

Figure 4.—The calibrated measuring strip.

Our measuring strips were used at commercial unloading sites in Maine to obtain information on the length-frequency distribution of commercially landed white hake. The application of this method appears to be a very quick and reliable means of converting headless white hake lengths directly into estimated total lengths. It is likely that the same method could be used to obtain estimated total length information on other commercial fishes landed headless such as anglerfish, *Lophius americanus* (Lyons and Creaser, 1986) and halibut, *Hippoglossus hippoglossus*.

Acknowledgments

We gratefully acknowledge the cooperation of the Maine fish dealers and fishermen who provided the assorted white hake samples used in this study. Appreciation is also extended to Margaret Hunter and Dave Sampson of the Maine Department of Marine Resources and Thurston Burns (NMFS Northeast Fisheries Center, Woods Hole, Mass.) for assistance in the statistical analysis of data, James Rollins of the Bigelow Laboratory for photographic services, and Russ Knowles of the Maine Department of Transportation for drafting and construction of fish measuring strips.

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Estimating Total Length of Headless Anglerfish, *Lophius americanus*, Landed in Maine

KERRY M. LYONS and EDWIN P. CREASER

ABSTRACT—Whole assorted anglerfish, Lophius americanus, *were obtained from eight locations along the Maine coast through prior arrangement with commercial dragger fishermen. Measurement of total length (L_T) and the distance from the anterior point of the 4th cephalic dorsal spine to the caudal fin (L_{CDS4}) was recorded for each fish. The slope, y-intercept, and correlation coefficient were calculated for the linear relationship L_T:L_{CDS4}.*

Polystyrene fish measuring strips were calibrated and marked in increments of 0.685 cm calculated from the above linear relationship. Each increment of 0.685 cm was equivalent to 1 cm and was marked as such on the strip. Measuring strips were calibrated to correct for a significant negative y-intercept value. Strips were inserted into slots on a special measuring board and two guide markers (ice picks) were positioned vertically at the 0 mark. Anglerfish tails from commercial vessels were placed on top of the strips and aligned between the two markers so that the anterior point of the 4th cephalic dorsal spine intercepted a line sighted between them. The estimated total length of the fish to the nearest cm was then read directly from the strip.

Introduction

The anglerfish, *Lophius americanus*, is a familiar species along the coast of eastern North America, ranging from the Grand Banks of Newfoundland and the northern side of the Gulf of St. Lawrence southward to North Carolina. They are found from shoal to moderately deep water of at least 365 fathoms on the continental slope off southern New England (Bigelow and Schroeder, 1953).

Anglerfish are commonly called "monkfish" (Maine), "goosefish" (Massachusetts), "molligut" (Connecticut), and "allmouth" (Carolina) (Dahlgren, 1928). The anglerfish is a close relative of the European species *Lophius piscatorius* (Wheller, 1969), which occurs in the eastern Atlantic from the Faroe Islands southward to the Cape of Good Hope (Bigelow and Schroeder, 1953). It is this close relative that was first observed and described by Aristotle under a Greek name which means frog-like fish (Dahlgren, 1928).

Although the anglerfish is not exceptionally abundant in the Gulf of Maine, it is consistently caught in commercial otter trawls. The catch per unit effort for this species runs from 5 to 16 pounds/hour towed and appears to be widely distributed along the Maine coast (Creaser and Lyons[1]).

The anglerfish is an excellent food fish, well flavored, white-meated and relatively free of bones when prepared properly (Bigelow and Schroeder, 1953). It also has a relatively high

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[1]Creaser, E. P., and K. M. Lyons. 1984. Annual report - Gulf of Maine model proposal, groundfish sampling. NMFS Northeast Fisheries Center, Woods Hole, Mass., 53 p.

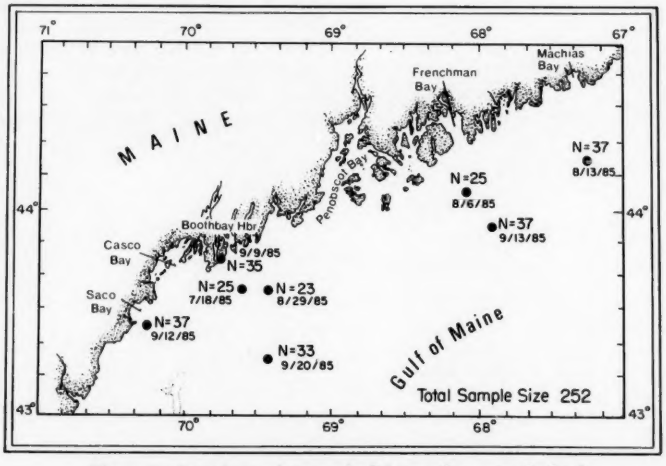


Figure 1.—Locations where anglerfish samples were obtained.

landed value, steadily increasing from $4,030 for 31,000 pounds in 1974 to $858,000 for 1,144,000 pounds in 1985. Still, little is known about the length composition of these species landed from Maine commercial fishing vessels, because they are landed with the head and shoulders removed. This study was made by port sampling personnel of the Maine Department of Marine Resources to develop a method of converting anglerfish tail lengths directly into total lengths at unloading facilities.

Materials and Methods

Anglerfish Collection

Anglerfish of varying sizes used in our study were obtained from areas representative of the entire Maine coast (Fig. 1) through prior arrangement with commercial fishermen who used otter trawls. Fish were ungutted, usually ice-cooled, and landed with heads intact. Sample size at each location was small (23-37 fish) because the commercial catch of this species is small. Fish were obtained from commercial operations (as opposed to research tows) because it was desirable to duplicate the conditions fish were subjected to prior to being landed commercially.

Measurements

Two measurements were obtained from whole fish supplied by commercial fishermen. Total length (L_T) was recorded in millimeters using a measuring board with a headstop, and measuring from the anterior edge of the lower jaw to the end of the caudal fin. It was necessary to grasp the upper and lower jaw at the corner of the mouth between the thumb and index finger and compress the anglerfish's mouth to a "standard closed position" before positioning the lower jaw against the headstop.

The tail section was removed from the anglerfish by cutting as indicated by dotted lines in Figure 2A. The resulting tail piece, with the anterior point of the 4th cephalic dorsal spine exposed, is shown in Figure 2B. The tail was measured on a board previously described by Creaser and Lyons (1985) (Fig. 3). The only change from the original board involved the use of two guide markers (ice picks) spaced 16 cm apart and inserted vertically into two holes located at the 0 mark (Fig. 3A). The tail section was aligned between the two markers so the anterior point of the 4th cephalic dorsal spine intercepted a line or sighting between them (Fig. 3B). The distance between this reference point and the end of the caudal fin (L_{CSD4}) was recorded in millimeters.

The anterior point of the 4th cephalic dorsal spine was chosen as the point of reference because it was the most anterior fixed point of measurement available. This point was nearly always exposed when the anglerfish tail was removed by commercial fishermen. The exact location of the cut is so consistent that the reference point is rarely damaged.

The anus was also considered as a point of measurement but it was located posterior of the tail cut and the tissue surrounding it was flacid and exhibited considerable movement.

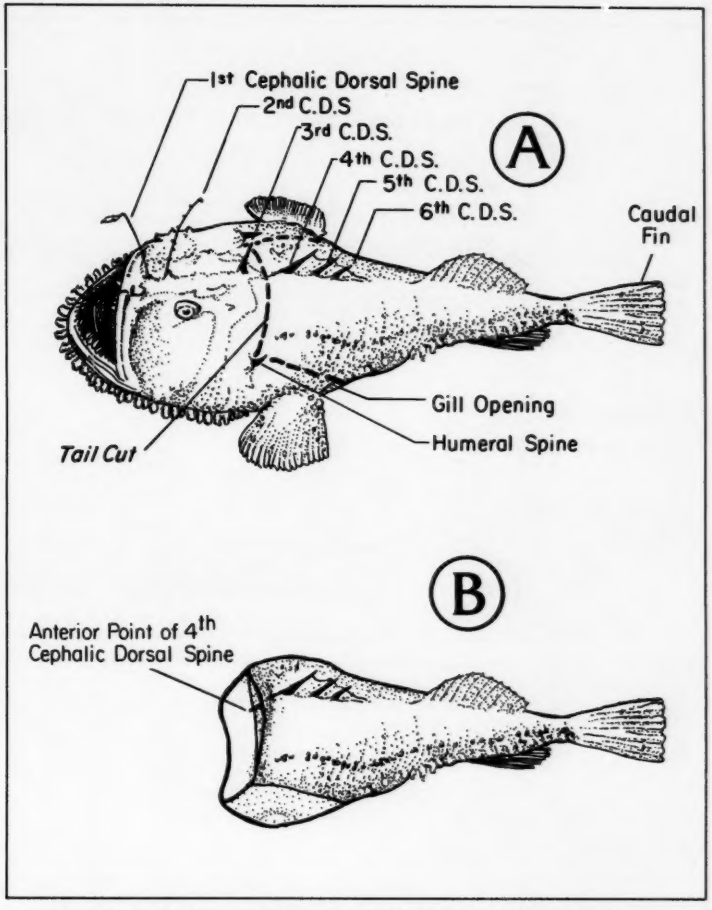


Figure 2.—Anglerfish and tail section: A) Labeled figure (dashed line denotes area of tailcut) and B) tail section as unloaded from commercial fishing boats.

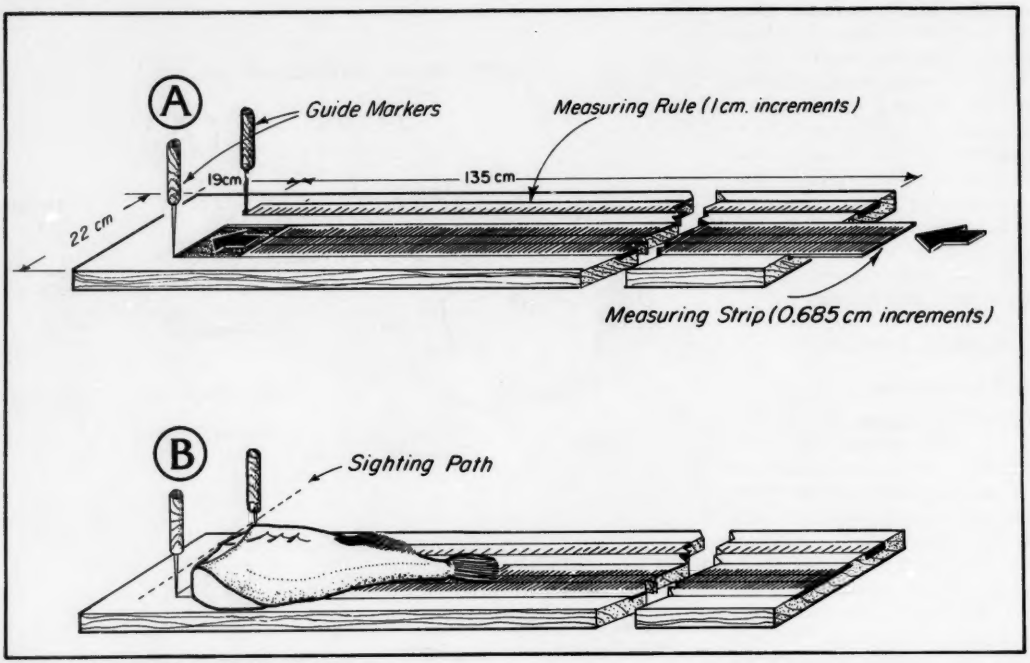
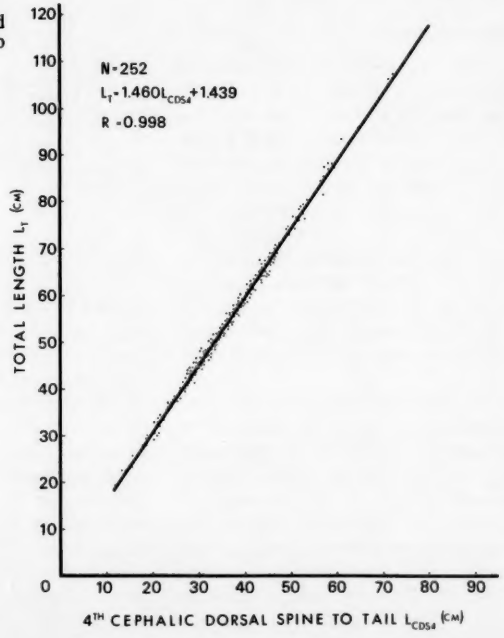


Figure 3.—The modified measuring board:
A) Component parts and B) measuring procedure.

Figure 4.—The relationship between L_T (total length) and the measurement L_{CDS4} (4th cephalic dorsal spine to caudal fin).



Results and Discussion

The linear relationship L_T:L_{CSD4} (Fig. 4) was calculated from combined data from eight sample locations. Figure 4 shows that a highly significant correlation coefficient of 0.998 exists.

The design and calibration of measuring strips used in this study is similar to that discussed by Creaser and Lyons (1985). The equation of the linear regression for L_T:L_{CDS4} is:

$$L_T = 1.460\ L_{CDS4} + 1.439. \quad (1)$$

Then solving equation (1) for L_{CDS4}, we find:

$$L_{CDS4} = 0.685\ L_T - 0.986.$$

Construction and Calibration

Fish measuring strips were constructed of polystyrene and measured 7.6 cm (width) × 101.6 cm (length) × 1.6 mm (thickness). Numbers and calibration increments were applied using silk screening techniques.

Measuring strips were calibrated and marked in 0.685 cm increments corresponding to the slope value of the linear relationship L_T:L_{CDS4}. Each increment was equivalent to 1 cm in length, rounded to the nearest centimeter, and was marked as such on the strip. The first increment was half the width of the following increments because lengths combined within each centimeter grouping included measurements 0.5 cm below and 0.5 cm above that grouping (Schultz[2]).

For instance, a fish measuring between 30.5 and 31.4 would be read as 31 cm (L_T) on the strip. It was necessary to modify the calibration of the strips and incorporate a correction for the y-intercept value, because this value (−0.986) was significantly different from 0 at 95 percent confidence limits. This was accomplished by subtracting a constant, or scaling factor, equivalent to the y-intercept value, to each calibrated increment on the strip (Fig. 5).

Calibrated measuring strips were inserted into the slot on the modified measuring board (lacking a headstop), and positioned next to the guide markers

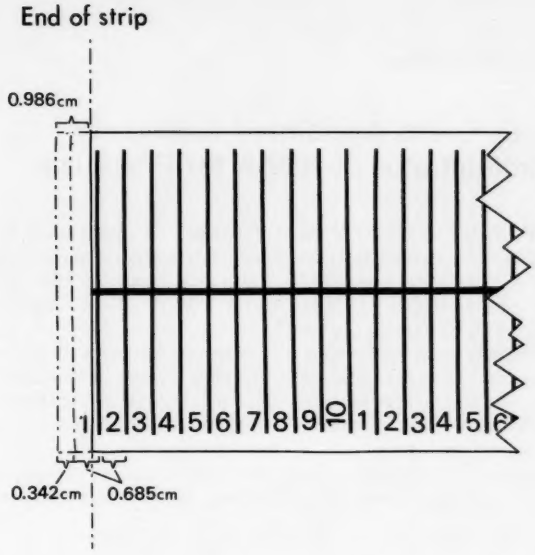


Figure 5.—The calibrated measuring strip for estimating L_T (4th cephalic dorsal spine to caudal fin).

(Fig. 3A). The anglerfish tail was placed on the strip and positioned so that the anterior point of the 4th cephalic dorsal spine intercepted the sighting path between the two guide markers. A pencil mark was then placed at the end of the caudal fin in the appropriate space which was numbered to correspond to the total length of the fish. Pencil marks from a No. 1 pencil were easily removed with liquid or powdered detergents; thus, the strips were reusable (Creaser and Lyons, 1985).

The application of calibrated measuring strips appears to be a very quick and reliable means of converting anglerfish tail lengths directly into estimated total lengths at commercial unloading sites.

[2]Schultz, R. L. 1974. Manual for sampling, interviewing, and coding for the Northeast Region. U.S. Dep. Commer., NOAA, NMFS Stat. Market News Div., Gloucester, Mass., 144 p.

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W. E. Evans Appointed Assistant Administrator of NOAA for Fisheries

William E. Evans, Chairman of the U.S. Marine Mammal Commission, has been named NOAA Assistant Administrator for Fisheries by Anthony J. Calio, Administrator of the Commerce Department's National Oceanic and Atmospheric Administration. As head of NOAA's National Marine Fisheries Service (NMFS), Evans will be responsible for the management and enforcement of fishery resources in the 200-mile-wide U.S. Fishery Conservation Zone and the protection and conservation of threatened and endangered marine mammals, Calio said. Evans has been Chairman of the U.S. Marine Mammal Commission since April 1984.

A marine zoologist, Evans has been Executive Director of the Hubbs Marine Research Institute in San Diego, Calif., since 1977. He is nationally recognized for his research on the biological and physiological effects of acoustics on the behavior of marine animals, including dolphins, sharks, whales, and tunas. He has worked with the NMFS in conducting aerial surveys to collect and evaluate data for stock estimates of dolphins. He has also done extensive research for the U.S. Navy on the dolphin's ability to navigate and to adapt to the ocean environment.

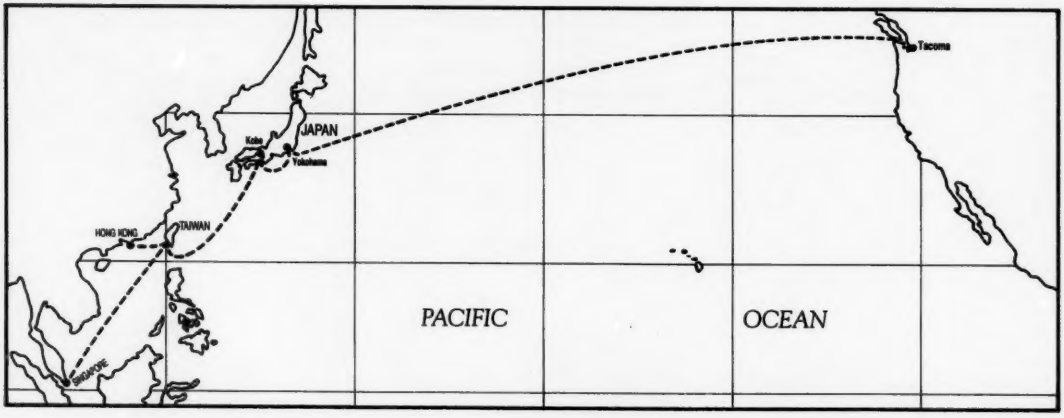
Evans earned a bachelor's degree in education from Bowling Green State University and received a master's degree from Ohio State University. He received his doctorate in biology and animal behavior from the University of California at Los Angeles. He is a member of numerous professional organizations and has taught at several major universities. He is married, has two sons and has resided in Escondido, Calif.

NMFS Agents Seize Record Shipment of Pacific Salmon

NMFS officials in Seattle, Wash., seized almost 595,000 pounds of Pacific salmon worth nearly $800,000 in a Tacoma, Wash., warehouse in September. The fish were reportedly bound for Taiwan to Japan by way of the U.S. port in an alleged multimillion dollar fish laundering scheme.

The record haul, believed to be part of over 3.5 million pounds of salmon worth $4,746,000 routed through Tacoma, consisted of chum, *Oncorhynchus keta*, and sockeye, *Oncorhynchus nerka*, salmon weighing from 4 to 6 pounds. It was seized by the NMFS enforcement agents in the course of a circuitous 13,000-mile round trip across the Pacific Ocean.

Japan prohibits the importation of Taiwanese-caught salmon, and salmon cannot legally be exported from Taiwan. The Commerce Department agency said that the salmon were shipped first to Singapore and Hong Kong. Then, a trading company in Costa Mesa, Calif., shipped the fish to Tacoma where, NMFS officials said, it was found labelled as squid instead of salmon. It is alleged that in Tacoma new container seals and bills of lading were used to obscure Taiwan as the country of origin, and that the salmon were to be re-



shipped to Japan—although it had already been in and out of Japanese ports.

The United States has a substantial salmon export market to Japan, and a U.S. bill of lading would be readily accepted there, fisheries officials noted. Sophisticated tests, the seized fish's appearance, including gillnet marks, and fishing patterns indicate they were caught on the high seas. The Taiwanese ban on salmon exporting and gillnetting was imposed at U.S. urging, in an effort to eliminate migratory interceptions and bring Taiwanese gillnetting practices under control. In addition to forfeiture of the fish, civil actions against the trading company, Union Inc., and its general manager, Young Ho Lee, were expected and civil penalties against the company and Lee could total $150,000.

The salmon seized in the containers were described as being "immature and 'bright' in appearance," which would indicate harvest on the high seas before undergoing the physical changes associated with their returning to their natal streams. In addition, they were described as bearing gillnet markings. However, the bills of lading indicated the contents of the containers were frozen squid bodies and threadfin and horse mackerel—products of Taiwan.

Photographs of seized Pacific salmon.

Assistant Administrator for NOAA's SDIS Named

Thomas N. Pyke, Jr., of Arlington, Va., was appointed Assistant Administrator of the National Oceanic and Atmospheric Administration (NOAA) for Satellite, Data, and Information Services earlier this year by Anthony J. Calio, NOAA Administrator. Pyke, 44, a career Federal science program manager, has been director of the Center for Programming Science and Technology at the Department's National Bureau of Standards (NBS), and he is an internationally recognized expert in computer sciences, research, testing, and systems engineering.

Pyke will be directing NOAA's civil operational environmental satellite program and managing an extensive system of environmental data collection and distribution centers. He will also be responsible for making NOAA's informational resources more useful to the public. A native of the Washington, D.C., area, Pyke earned a bachelor's degree in electrical engineering as a Westinghouse Scholar from the Carnegie Institute of Technology in Pittsburgh, Pa., and a master's degree in computer systems, as a Ford Foundation Fellow, from the University of Pennsylvania. He joined the Bureau of Standards in 1960 as a student trainee specializing in computer hardware and software design. He is a member of numerous professional organizations and has published over 25 scientific papers and reports.

Foreign Catches of U.S. Atlantic Salmon Reduced

The North Atlantic Salmon Conservation Organization (NASCO) acted at its third annual meeting in Edinburgh, Scotland, during June 1986 to reduce harvests of Atlantic salmon, *Salmo salar*, of U.S. origin when these fish are outside U.S. waters, reported Allen E. Peterson, Director of the NMFS Northeast Fisheries Center and head of the U.S. Delegation to NASCO.

Atlantic salmon originating in New England rivers annually migrate along Canada both to get to and return from their summer feeding grounds off West Greenland. Duing this feeding and migration period, commercial fishermen off West Greenland and Canada harvest these U.S.-origin salmon. The number of U.S. fish harvested by these foreign fishermen often exceeds the number finally returning to U.S. rivers.

In NASCO's North American Commission, whose members include Canada and the United States, the United States proposed that Canada close its 1986 commercial fisheries in Newfoundland and Labrador on 1 September due to the high percentage of U.S.-origin salmon harvested off those Canadian provinces during the fall. Canada agreed to a 15 October closure. Historically, these fisheries have closed on 31 December.

In NASCO's West Greenland Commission, whose members include Canada, Denmark (in respect of Greenland), the European Economic Community, and the United States, the members agreed to an 850 metric ton (t) total allowable catch (TAC) based on a 1 August opening for both the 1986 and 1987 seasons. The agreement stipulates that if the opening is changed to a later date, the TAC may be increased according to the projected increase in weight of the salmon between 1 August and the later opening. The Home Government of Greenland elected to open the salmon fishery on 15 August with an increased TAC of 909 t. Although a smaller TAC would produce a larger return of U.S.-origin salmon, having the TAC set for 2 years instead of one will stabilize the West Greenland fishery in the face of continued pressure for higher TAC's.

Peterson said that "the measures adopted by NASCO's North American and West Greenland Commissions clearly support U.S. efforts to restore its historical salmon runs by allowing additional salmon to return to their home waters. In Canada alone, we expect these measures, along with other measures taken over the last 2 years, to reduce Canadian harvests of U.S. fish upwards of 30 percent."

Peterson added that "It's gratifying to see that salmon producing and salmon harvesting nations can, in fact, work together to reverse the continuing worldwide decline of Atlantic salmon runs."

In other actions taken at the NASCO annual meeting, the North American Commission adopted proposals to investigate the impact of acid rain on Atlantic salmon and the effects of introducing and transferring Pacific salmon into the Great Lakes and along the Atlantic seaboard. The NASCO Council, which oversees all three Commissions (North American, West Greenland, and North East Atlantic), elected Allen Peterson to a second term as Vice President, and the North American Commission elected Frank E. Carlton, a U.S. Commissioner from Savannah, Ga., as its Chairman.

The purpose of the treaty establishing NASCO is to promote the conservation, restoration, enhancement, and rational management of salmon stocks in the North Atlantic Ocean by means of international cooperation. NASCO also provides for the acquisition, analysis, and dissemination of scientific information on these stocks. The members are Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Economic Community, Finland, Iceland, Norway, Sweden, and the United States. The USSR is expected to join NASCO in the near future.

N.E. Offshore Lobster Gear Marking Rules Set

Effective 22 June 1986, Federal regulations require that all offshore lobster gear be marked according to a recently approved uniform gear marking system. The new regulations require that:

1) Lobster pot trawls of three or less pots be marked with a single buoy;

2) Trawls consisting of more than three pots have a radar reflector and a single flag or pennant on the westernmost end (marking the half compass circle from magnetic south through west to and including north), and that the easternmost end of the trawl (meaning the half compass circle from magnetic north through east to and including south) be marked with a radar reflector only;

3) Radar reflectors are to be standard tetrahedral corner radar reflectors of at least 8 inches (both in height and width) and made of metal; and

4) Lobster pot trawls are not to exceed 1½ miles in length as measured from buoy to buoy.

This uniform marking system is intended to be used in the offshore lobster fishery, as defined by the following areas of applicability:

1) Gulf of Maine Gear Area—All waters of the U.S. fishery conservation zone south of lat. 42°20′N seaward of a line drawn 12 miles from the baseline of the territorial sea (state waters).

2) Georges Bank Gear Area—All waters of the fishery conservation zone south of lat. 42°20′N and east of long. 70°00′W, or the outer boundary of the territorial sea, whichever lies further east.

3) Southern New England Gear Area—All waters of the fishery conservation zone west of long. 70°00′W and east of long. 71°30′W at a depth greater than 25 fathoms.

4) Mid-Atlantic Gear Area—All waters of the fishery conservation zone west of long. 71°30′W and north of lat. 36°33′N at a depth greater than 40 fathoms.

These gear marking requirements were included in an amendment to the American Lobster Fishery Management Plan, which was prepared by the New England Fishery Management Council and approved by the National Marine Fisheries Service. The amendment also clarifies that red crab gear set beyond 200 fathoms is not gear capable of taking lobster. As such, this gear is not subject to the provisions of the lobster regulations. In addition, the amendment

provides authority to the Regional Director to grant exemptions from the regulations and/or close areas for research or educational purposes beneficial to the lobster resource. Questions on the rules should be directed to Carol J. Kilbride at (617) 281-3600 extension 331.

New FMP Implemented For N.E. Groundfish

A new Fishery Management Plan for the entire range of bottom-dwelling fish found in the North Atlantic went into effect on 19 September 1986, according to Richard Schaefer, acting director of the National Marine Fisheries Service's Northeast Region in Gloucester, Mass. The new Northeast Multispecies Plan will replace the current Interim Plan which was in place for 4 years. The Multispecies Plan is broader in scope than the three-species Interim Plan, as it aims at managing 10 valuable species in the complex of important demersal (bottom living) species: Atlantic cod, haddock, yellowtail flounder, pollock, redfish, American plaice, white hake, and the winter, windowpane, and witch flounders.

According to the New England Fisheries Management Council, developer of the Plan, the objective is to control or reduce fishing mortality primarily on juvenile fish, but also on adults. The approach is to allow enough spawning so that these fish populations can recover from the pressure of fishing and replace themselves. The ultimate goal is to promote a healthy fishery. The Council hopes to accomplish its goal through Multispecies Plan measures which are more stringent than those of the Interim Plan.

Schaefer profiled the Multispecies Plan as having new minimum fish sizes for seven major commercial species and minimum sizes for cod and haddock taken by recreational fishermen; a 1-month extension for haddock spawning closed areas; a closed area in southern New England to protect juvenile fish; a stricter program governing the use of small mesh as well as the 5½-inch regulated mesh; marking requirements for gillnets; a Technical Monitoring Group to recommend further measures to ensure effective conservation and an annual fishing permit. Schaefer stated that the NMFS will monitor the Plan, work closely beside the Council, and will be prepared to implement additional measures when necessary to ensure the Plan's success. For copies of the regulations or detailed information, call 617-281-3600 extension 252.

NWAFC Hosts Fisheries Acoustics Symposium

The third "International Symposium on Fisheries Acoustics (ISFA)" is scheduled for 22-26 June 1987 under the sponsorship of the NMFS Northwest and Alaska Fisheries Center in Seattle, Wash. It has been organized with the assistance of the International Council for the Exploration of the Sea (ICES) and the Food and Agriculture Organization (FAO) of the United Nations and will provide an interdisciplinary review of the uses of acoustics in fisheries science and management.

The principal themes of the Symposium are: 1) Survey-based stock assessment and management results and their evaluation; 2) the accuracy and repeatability of calibration measurements and the factors affecting quantitative assessments; 3) advances in acoustic techniques and auxiliary technology, and the limitations imposed by physics and biology; 4) the patchiness of fish and plankton populations and the problems of direct and remote sampling for species and size distributions; and 5) special topics, including (but not limited to) applications of acoustics in population and ecosystem modeling, the instrumentation of sampling gear, biological oceanography, environmental monitoring, and aquaculture.

Registration should be made before 15 March 1987. For further information contact Martin O. Nelson, Chair, ISFA Steering Committee, Division of Resource Assessment and Conservation Engineering, NMFS Northwest and Alaska Fisheries Center, 7600 Sand Point Way, N.E., Bin C15700, Building 4, Seattle, WA 98115-0070, U.S.A.

Bluefish Safe to Eat

Bluefish, *Pomatomus saltatrix*, the main Atlantic Coast sport fish, are not only great sport fish but they are safe to eat, the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) has announced. Their pesticide levels show no health threat and PCB (polychlorinated byphenyl) levels for all but some of the largest bluefish are within the 2 parts per million set by the Food and Drug Administration (FDA), according to NOAA's National Marine Fisheries Service.

The announcement revealed preliminary results of a 12-month study, largest of its kind ever conducted, by NOAA in cooperation with the FDA and the Environmental Protection Agency (EPA). A final report will be issued in December. This study, involving more than 3,400 bluefish caught from Maine to Florida, shows that levels of PCB's in commercially available bluefish pose no health threat for the public, primarily because bluefish constitute only a small portion of the diet of most fish eaters. The study stated, however, that there "might be health concerns" for those who consume contaminated bluefish daily for several years. Nevertheless, the FDA said even those groups that eat bluefish from areas of the highest PCB levels would not be endangering their health during the next few months, while the data are being analyzed for the final report.

The annual bluefish catch has been more than 130 million pounds in recent years. In 1985, commercial landing totalled almost 14 million pounds, worth about $2.4 million. The 179-page study, "Report on 1984-86 Federal Survey of PCBs in Atlantic Coast Bluefish," was requested by the U.S. Congress in 1984.

Hawaii Deepwater Shrimp Research Is Encouraging

The deepwater Hawaiian "ono" shrimp, a striking bright red shrimp which is harvested by trapping in water 2,000 feet deep, has for several years been of considerable interest to the local

fishing industry for its development potential, reports Richard S. Shomura, Director of the NMFS Southwest Fisheries Center's Honolulu Laboratory. Last summer, laboratory scientists on the NOAA ship *Townsend Cromwell* completed a 16-day research cruise to assess a segment of that resource.

Steve Ralston, Chief Scientist on the cruise, reports that over 1.5 tons of shrimp were caught at a small 3-square-mile study site situated in mid-channel between the islands of Kauai and Niihau. The shrimp were generally large, with an average size 1.2 ounces each. The preliminary catch rate experienced at the study site was 50 pounds per trap for an overnight soak, but after 13 days of concentrated fishing this had declined to slightly less than 25 pounds, although the size of shrimp remained large throughout. Based on the results of the cruise, Ralston estimated that the initial abundance of harvestable shrimp in the area was about 1 ton per square mile of bottom. Although the study site visited was characterized by an initial catch rate that was unusually high, the results were encouraging for those attempting to develop a local fishery for this species.

Cooperation Needed in Atlantic Salmon Program

The Federal Government's program to restore the Atlantic salmon, *Salmo salar*, to rivers in the northeastern United States has encountered a couple of problems, according to Allen E. Peterson, Jr., Director of the National Marine Fisheries Service's Northeast Fisheries Center in Woods Hole, Mass. "The first problem," notes Peterson, "is the hesitancy of some fishermen along the coast of eastern Canada to return tags to the Fisheries Center taken from salmon that they have harvested because of uncertainty over whether Canadian citizens qualify for the $8.00 (U.S.) reward." Peterson noted that "anyone, U.S. citizen or not, qualifies for the reward."

"The second problem is the incidence of a few fishermen in the northeastern United States in unsuspectingly returning tags from illegally harvested salmon." Salmon cannot currently be legally harvested in some northeastern U.S. rivers. These closures are designed to protect small hatchery-produced salmon until they descend to the sea where they can grow, mature, and then someday return as large, highly prized gamefish.

The tagging program, a joint effort between the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the New England states, attaches tags to about 150,000 of the million-plus hatchery-produced juvenile or smolt Atlantic salmon which are annually released into the Connecticut River, the Merrimack River, and various Maine rivers. Each ⅝-inch long, green or blue-colored tag is attached behind the dorsal fin of the 7- to 9-inch long smolt, and has a number on one side and the phrase, "REWARD, NMFS, WOODS HOLE, MASS., USA 02540," on the other side. To claim the $8.00 reward, fishermen catching legal salmon should send the tag to the Fisheries Center along with information on when, where, and how (rod and reel, trap net, etc.) caught, and the length and weight (if possible) of the fish.

Peterson indicated that "our ability to manage Atlantic salmon depends upon our knowledge of their habits, and we need to know more about their habits at sea, including routes of migration, timing of migration, and areas of concentration." Tag returns provide that knowledge, but some Canadian fishermen are reluctant to return tags, in part, because of a feeling that only U.S. fishermen can claim the U.S. reward. Peterson countered that "the reward will be paid to any party who returns a tag along with the requested information on its capture."

On the other hand, some American fishermen have returned tags from salmon caught in the Connecticut River and its tributaries when there was a ban on keeping salmon caught in those waters. A total ban on keeping salmon caught in the main stem of the Connecticut River is now in effect until further notice by all four states bordering the river (Connecticut, Massachusetts, New Hampshire, and Vermont), both to protect the smolts until they can descend the river to reach the sea, and to protect the returning adults which are the broodstock of the whole restoration program.

It's unclear whether fishermen returning tags from illegal fish have misidentified the salmon smolt as another species (brown trout, rainbow trout, etc.), are unaware of the applicable state ban, or feel that tag-bearing fish are exempt from the ban (which they are not).

Peterson states that "the Fisheries Center will continue to pay rewards for tags taken from any salmon regardless of the apparent circumstances of harvest." He added, though, that "in order to reduce the harvest of tagged smolts next spring, the Fisheries Center will undertake an educational campaign with the U.S. Fish and Wildlife Service and the New England states to help fishermen better distinguish between small salmon and small trout, and to be aware more fully of all state regulations pertaining to salmon fishing."

Curd Reduction in Canned Frozen Salmon

Recent research by the Utilization Research Division (URD) of the NMFS Northwest and Alaska Fisheries Center shows that phosphate treatment of thawed sockeye and pink salmon prior to canning is effective in reducing the curd that forms during the retorting process. Currently the research is being directed toward phosphate treatment of boneless and skinless salmon packed chunk-style in the can. The results are even more dramatic than when normal skin-on, bone-in fish is canned.

The treatment of the skinless fish cut in chunks allows thorough and uniform application of the phosphate. Curd formation is minimized by the treatment. The canned salmon has a very attractive appearance and the flavor and texture is superior to fish canned without treatment. The industry has shown a great deal of interest in this development because, first, it would provide the means of producing a highly acceptable canned salmon from frozen fish, and second, because there seems to be a demand for canned salmon that is free of skin and bones. Source: Richard W. Nelson, URD, NWAFC, Seattle, Wash.

Japan's Herring and Herring Roe Supplies and Trade

Introduction

Herring and herring roe have traditionally been seafood favorites of the Japanese. Japan is virtually the world's only market for herring roe—which is considered a great delicacy by Japanese consumers. It is also an expanding market for food herring. Japan currently relies almost exclusively on imported herring roe and roe herring (herring that will be processed in Japan to extract the roe) to supply consumer demand. A small Pacific herring fishery exists in Japan, but the harvest is processed mostly for food and not for the roe.

The United States and Canada are the principal suppliers of both herring and herring roe to the Japanese market (Tables 1-4). While almost all U.S. exports are shipped as roe herring for extraction and further processing in Japan, Canadian shipments are predominantly processed herring roe, as Canadian regulations limit the export of Pacific roe herring so that added value can be obtained by extracting the herring roe in Canada. Improving North Atlantic herring catches have enabled several European countries to increase herring and herring roe exports to Japan in recent years, thus intensifying competition in the Japanese herring market.

Japan's Herring Harvest

Japanese fishermen harvest Pacific herring in both a spring and a fall fishery; the spring fishery occurs in coastal waters around Hokkaido and northern Honshu, while the fall fishery is in the East China Sea off Kyushu. The harvest from the domestic fishery is utilized for food in Japan, either as a fresh product, or as dried herring. Japanese fishermen formerly harvested much larger amounts of herring than they do currently; a record-high post-World War II herring catch was reported in 1952, when herring harvests amounted to nearly 321,000 metric tons (t). Since 1970, however, the largest annual catch was made in 1971, when 162,000 t were harvested by Japanese fishermen. The emergence of 200-mile fishing zones has restricted Japanese access to North Pacific herring fishing grounds and Japan's herring harvest was only 6,800 tons in 1984 (Table 5).

Japan must rely on supplies from foreign harvesters and processors for roe herring and herring roe, as local herring stocks are not large enough to support a roe herring fishery. Japan was formerly able to supply the domestic demand for herring, but the gradual loss of access to distant-water herring stocks in the North Pacific—mostly in what is now the Soviet Union's 200-mile zone—left the Japanese with little choice but to depend upon foreign suppliers. Japanese importers first turned to Canadian and U.S. herring roe and roe herring suppliers in the early 1970's, after a 1971 Japanese-Soviet fishery agreement banned the harvest of roe herring north of lat. 52°N in the Sea of Okhotsk. The ban was enacted because herring stocks

This report was prepared by George Herrfurth, Foreign Affairs Specialist, Office of International Fisheries, National Marine Fisheries Service, NOAA, Washington, DC 20235. Mention of trade names or commercial firms or associations does not imply endorsement by the NMFS.

Table 1.—Japanese herring imports (excluding roe) by commodity and country, 1979-85, in metric tons.

Commodity and country	Herring imports (t)						
	1979	1980	1981	1982	1983	1984	1985
Fresh							
United States	1.7				1.1		
Norway	—				—		197.3
Total	1.7				1.1		197.3
Frozen[1]							
United States	6,429.5	21,547.9	22,342.8	30,972.6	38,083.5	31,760.3	34,072.0
Canada	6,194.9	7,563.7	23,451.6	23,141.4	9,081.7	5,755.5	5,054.6
China		7.8	229.6	52.1			107.1
N. Korea (DPRK)		120.4	223.9	503.1	635.9	233.2	52.4
U.S.S.R		36.5	269.2	1,769.0		316.6	
S. Korea (ROK)	479.4	450.0	187.8		59.9		
Europe							
Norway				8.2	470.1	10,444.9	18,301.7
Netherlands			2,913.8	2,632.3	3,880.5	4,775.7	11,168.2
Sweden		418.1	499.1	36.6	371.3	691.3	1,215.2
United Kingdom	10.8			409.8		448.4	914.3
Ireland				19.5	32.9	281.0	194.8
Italy							138.5
Denmark				18.7	49.2	13.8	73.4
Iceland	188.5			300.5	461.5	339.5	65.2
Finland	413.6						
West Germany			negl.	53.8			
France	—	—	—	—	5.6	—	—
Subtotal	612.9	418.1	3,412.9	3,479.4	5,271.1	16,994.6	32,071.3
Other	23.3			1.0	35.1		210.0
Total	13,740.0	30,144.5	50,117.8	59,918.5	53,167.1	55,060.2	71,567.6
Salted							
United States	726.8	1,873.7	8.6	339.8	1,442.6		
Canada		76.5		0.9			
U.S.S.R.		15.6	30.6	80.6			
S. Korea (ROK)			100.9	46.1			
Other	—	—	60.3	—	—	—	0.9
Total	726.8	1,965.8	200.4	467.5	1,442.6		0.9
Grand total[2]	14,468.5	32,110.3	50,318.2	60,386.0	54,610.8	55,060.2	71,765.8

[1]Includes the imports of round roe herring.
[2]Totals may not agree because of rounding.

in the Sea of Okhotsk were being seriously depleted by overfishing. In 1977, when the Soviet Union adopted a 200-mile fisheries zone, Japanese fishermen were prohibited altogether from harvesting herring in Soviet waters. Between 1976 and 1978, the Japanese harvest of Pacific herring decreased from 65,200 t to only 6,760 t. This necessitated the liberalization of Japanese herring import quotas by the Government, because the strict quotas were no longer protecting a domestic herring fishery of any consequence. The resulting liberalization opened the Japanese market to U.S. and Canadian exporters.

In an attempt to revive Japan's coastal herring fishery, Japanese fishery biologists successfully hatched 180,000 fertilized herring eggs in 1982, from which 84,000 fry were raised and released in coastal waters. In 1983, this experiment was repeated when 250,000 herring eggs were hatched and 200,000 herring fry released in Japanese waters near Akesshi in Hokkaido. It is not known what consequence, if any, the viability of herring enhancement by Japan will have vis-a-vis an increased domestic herring harvest. The 1983 experiments were conducted by the Japan Sea Farming Association and more recent information regarding herring enhancement efforts is unavailable.

Table 2.—Japanese herring imports (excluding roe) by commodity and country, 1979-85, in thousands of dollars.

Commodity and country	Herring imports (US$1,000[1])						
	1979	1980	1981	1982	1983	1984	1985
Fresh							
United States	2.8				1.6		
Norway							202.8
Total	2.8				1.6		202.8
Frozen[2]							
United States	17,108.5	37,549.0	37,994.0	47,820.8	69,192.7	50,242.3	76,988.7
Canada	4,758.0	8,555.1	24,136.9	21,773.3	7,960.5	5,276.2	4,474.6
N. Korea (DPRK)		92.5	341.4	430.0	670.4	474.5	59.0
China		4.7	188.0	47.9			54.8
S. Korea (ROK)	214.2	145.9	255.8		60.0	196.5	
U.S.S.R.		32.1	506.7	2,036.7			
Europe							
Norway				9.1	457.8	9,007.0	18,482.5
Netherlands			2,699.0	2,118.2	2,530.9	2,380.9	6,512.6
Sweden		463.2	539.6	40.9	333.9	665.2	1,215.2
United Kingdom	42.8			406.3		371.0	600.3
Ireland				20.2	32.1	180.0	146.2
Italy							133.0
Denmark				17.2	47.4	14.1	86.0
Iceland	206.6			301.8	393.8	250.2	53.7
West Germany			0.5	50.0			
Finland	451.3						
France					5.4		
Subtotal	700.7	463.2	3,239.1	2,963.9	3,801.3	12,868.4	27,229.5
Other	22.5		0.5	1.0	28.7		130.0
Total	22,803.9	46,842.5	66,662.1	75,073.6	81,713.5	69,058.0	108,936.7
Salted							
United States	1,392.2	2,206.3	29.4	440.7	1,280.6		
U.S.S.R.			49.9	68.2	99.4		
Canada			43.8		1.1		
S. Korea (ROK)				509.1	61.3		
Other				84.7			2.8
Total	1,392.2	2,300.0	691.4	602.5	1,280.6		2.8
Grand total[3]	24,198.9	49,142.5	67,353.5	75,676.1	82,995.7	69,058.0	109,142.3

[1]Values are approximate and based upon annual International Monetary Fund (IMF) average exchange rates.
[2]Includes the import of round roe herring.
[3]Totals may not agree because of rounding.

The Domestic Market

There are two markets for herring (nishin) in Japan: The market for food herring and the market for herring roe. The market for food herring is supplied by both the domestic fishery and imports, while the herring roe market is entirely dependent upon imports. The herring roe market is by far the more lucrative of the two markets because of its status as a highly desired delicacy.

Food Herring

Herring is consumed either fresh or dried in Japan. The fresh herring market is supplied by the Japanese domestic fishery, as well as by imports. The imports consist of both Atlantic and Pacific herring and are generally shipped frozen to Japan and then thawed for sale to consumers. A major portion of the dried herring (migaki nishin) market is reportedly supplied from the Japanese coastal herring catch, although the declining catch has also forced migaki nishin processors to also import Pacific herring. No data are available on the amount of fresh or dried herring consumed annually in Japan.

Herring Roe

Herring roe is a traditional seafood delicacy in Japan and has been described as "indispensable" for ceremonial occasions such as the New Year holiday (shogatsu) and weddings. Known as "kazunoko," much of the herring roe that is consumed in Japan is dried, salted, and packed in little boxes which are given as gifts during shogatsu. Kazunoko is such a highly desired (and expensive) delicacy that it is often referred to as "yellow diamonds" by the Japanese. The consumption of kazunoko during shogatsu signifies family prosperity and numerous progeny. Observers estimate that 60 percent of the kazunoko is consumed during shogatsu; the other 40 percent is consumed year round in restaurants and drinking establishments which serve it as an appetizer or as a side-dish. While the kazunoko used during shogatsu is usually high-quality roe that is contained within the natural skein (ovisac) of the herring, the restaurant and drinking establishment roe is generally of lower quality and is served "broken", i.e., without the skein.

Another popular and expensive herring roe delicacy in Japan is "komuchi konbun," or herring roe on kelp. Komuchi konbun is processed in brine and the United States and Canada are currently Japan's only source. Shipments to

Table 3.—Japanese herring roe imports, by commodity and country, 1979-85, in metric tons.

Commodity and country	Roe imports (t)						
	1979	1980	1981	1982	1983	1984	1985
Frozen							
Canada	492.0	380.4	438.1	940.0	1,492.9	2,918.6	4,651.7
Trinidad/Tobago							62.9
United States		1.3	0.3	0.6	2.4	3.5	19.3
Other							3.6
Europe							
Ireland				73.9	169.5	245.1	227.7
West Germany							88.5
Denmark				8.5	5.0	14.6	47.3
Netherlands				4.8	6.1	24.0	25.2
Finland	4.2	12.0	27.8	30.0	39.9	12.5	25.1
Iceland	0.1	0.4					18.3
France							9.7
Norway		0.4				8.0	6.5
United Kingdom				1.4			0.9
Sweden					0.4	2.4	
Subtotal	4.3	12.8	27.8	118.6	220.9	306.6	449.2
Total frozen	496.2	394.1	466.2	1,059.2	1,716.2	3,228.6	5,186.5
Cured[1]							
Canada	5,107.1	2,292.7	4,185.3	4,722.1	5,638.8	4,683.9	4,001.1
United States	1,090.3	1,439.2	1,767.8	1,501.5	1,246.8	878.3	1,626.5
China	857.8	855.1	469.3	399.4	915.9	556.4	617.1
S. Korea (ROK)	569.1	655.6	1,006.6	731.5	335.6	375.2	829.8
U.S.S.R.	85.2	151.9	180.3	26.6	75.6	415.4	69.8
N. Korea (DPRK)	5.1	20.6	24.9	66.0	189.5	101.3	50.8
Europe							
Denmark				9.4	143.9	227.1	227.5
Finland	9.1		10.5	39.4	68.2	57.4	143.0
Netherlands	0.8	0.5	0.4	0.4		0.1	67.0
West Germany					11.1	8.2	25.5
Norway			0.2	0.3		2.4	15.9
Sweden				0.1	2.9		7.7
France							1.6
Ireland						3.8	
Subtotal	9.9	0.5	11.1	49.6	226.1	299.0	488.2
Total cured	7,724.4	5,415.7	7,645.3	7,496.8	8,628.1	7,309.4	7,683.3
On kelp							
Canada	214.2	239.9	172.9	180.0	213.1	156.6	209.1
United States	292.6	304.3	211.7	282.0	293.5	198.9	41.2
Total on kelp	506.8	544.2	384.6	462.0	506.6	355.5	250.3
Grand total[2]	8,727.4	6,354.0	8,505.1	9,018.0	10,850.9	10,893.5	13,120.1

[1]Dried, salted, or smoked.
[2]Totals may not agree because of rounding.

Japan include both natural and induced herring spawn-on-kelp. Canadian companies developed the practice of inducing herring to spawn on artificially prepared kelp beds, at an earlier date that U.S. producers. However, induced spawning on cut kelp is now being conducted by U.S. fishermen in Alaska's Prince William Sound.

Japanese herring roe importers purchase both Atlantic and Pacific herring roe from foreign suppliers in order to supply the domestic market. Because Japanese consumers prefer the taste and texture of the higher-priced Pacific herring roe over Atlantic herring roe, much of the higher-quality Pacific herring roe imports are destined for the shogatsu gift market, while both Atlantic and lower-quality Pacific herring roes are consumed in the year round market, either in restaurants, drinking establishments, or in private households.

The Japanese herring roe market has often been subject to speculation and controversy. The greatest controversy occurred during 1979-80, when a Japanese herring roe trading firm, Hokusho Co., collapsed, causing the largest bankruptcy in the history of the Japanese fishing industry. Over $100 million worth of debts was the outcome of the collapse, which was the result of price speculation that pushed prices higher than the market would bear. Japanese herring roe traders believed that consumers would pay any price to buy their holidy kazunoko. They pushed prices so high that consumers revolted and refused to buy the high-priced roe. As a result, only half of the seasonal kazunoko was sold and wholesale prices for the delicacy fell from $26 to $9 per pound. Hokusho, which stockpiled large amounts of herring roe purchased at high prices, was ruined by the collapse of the kazunoko market. Since 1979-80, observers note that kazunoko speculation by Japanese herring roe traders has been greatly curtailed.

Japan's Herring Imports

Between 1979 and 1984, herring and herring roe shipments to Japan accounted for an increasing percentage of total fishery imports. For example, Japanese importers purchased 23,200 t of herring commodities in 1979 (Fig. 1), or about 1.8 percent of Japan's total fishery imports that year (1.15 million tons). In 1984, herring commodity imports were nearly 66,000 tons—about 4.7 percent of Japan's total fishery imports (1.39 million tons). Japan's herring commodity import increase is related to both a liberalization of the Government-imposed round herring import quota, a gradual decrease in tariffs, and the increased availability of herring and herring roe from the North Atlantic. In 1985, Japan's imports of 84,900 t of herring commodities outpaced the record-high import of 69,400 t set in 1982 (Fig. 1 and Tables 1 and 3).

Import Restrictions

The Japanese Government regulates herring commodity imports through the use of tariff and nontariff barriers. Imports of herring face both import quota restrictions and ad valorem duties. Unlike round herring, shipments of herring roe to Japan are not restricted by an import quota because the Japanese no longer have a roe herring fishery. Nevertheless, herring roe imports are also assessed duties by the Japanese Government.

Import Quota

Japan controls imports of herring but not herring roe through a quantitative restriction known as an import quota.

Table 4.—Japanese herring roe imports, by commodity and country, 1979-85, in thousands of dollars.

Commodity and country	Roe imports (US$1,000[1])						
	1979	1980	1981	1982	1983	1984	1985
Frozen							
Canada	4,027.6	2,028.5	2,669.8	7,262.7	8,350.9	17,949.4	27,668.8
United States		6.7	1.8	3.0	16.9	18.5	106.3
Other							29.2
Europe							
Ireland				330.6	870.8	1,277.7	1,552.2
West Germany							490.3
Finland	10.5	107.9	244.5	261.4	323.3	107.1	240.9
Netherlands				18.4	15.6	88.8	135.5
Denmark				19.6	9.1	29.1	103.0
France							49.1
Norway		0.8				15.6	25.9
United Kingdom				2.5			6.3
Sweden					4.6	20.3	
Iceland	0.7						
Subtotal	11.2	108.7	244.5	632.5	1,218.8	1,538.6	2,603.2
Total frozen	4,038.9	2,144.0	2,916.1	7,898.2	9,591.2	19,506.5	30,407.5
Cured[2]							
Canada	171,758.4	35,184.0	62,681.6	70,242.4	87,623.8	69,496.5	90,216.4
United States	31,472.4	20,205.1	24,381.1	21,402.2	20,854.9	12,568.3	31,999.0
S. Korea (ROK)	19,870.4	10,889.6	13,948.7	12,716.2	5,693.1	6,209.9	15,981.2
China	19,767.4	8,731.4	5,203.0	5,902.1	15,067.8	7,415.8	10,575.0
U.S.S.R.	2,253.1	1,708.2	2,314.1	395.0	846.0	4,878.8	1,181.9
N. Korea (DPRK)	55.5	77.2	90.5	264.6	737.0	496.3	368.2
Europe							
Finland	28.4		58.6	245.2	449.8	258.8	1,210.1
Denmark				15.6	313.5	567.3	580.0
Netherlands	3.2	2.7	1.9	2.3		0.9	348.1
Norway			0.7	1.1		7.6	85.6
West Germany					97.0	26.1	144.5
Sweden				2.4	26.4		31.5
France							12.1
Ireland						30.8	
Subtotal	31.6	2.7	61.2	266.6	886.7	891.5	2,411.9
Total cured	245,209.8	76,798.5	108,680.2	111,189.1	131,709.5	101,957.1	152,733.5
On kelp							
Canada	4,155.2	2,778.0	2,809.9	3,435.3	4,925.7	3,449.0	6,019.4
United States	2,643.5	1,760.8	1,104.9	1,718.9	1,855.4	994.6	565.4
Total on kelp	6,798.7	4,538.8	3,914.8	5,154.2	6,781.1	4,443.6	6,584.8
Grand total[3]	256,046.4	83,481.3	115,511.1	124,241.5	148,081.8	125,907.2	189,725.8

[1]Values are approximate and are based upon International Monetary Fund (IMF) exchange rate averages.
[2]Dried, salted, or smoked.
[3]Totals may not agree because of rounding.

Table 5.—Japanese herring harvests by quantity and species, 1970-84.

Year	Catch (1,000 t)		
	Atlantic	Pacific	Total
1970		97.4	97.4
1971	3.2	158.8	162.0
1972	2.7	59.5	62.2
1973	2.9	79.8	82.7
1974	3.4	72.8	76.2
1975	2.1	64.5	66.6
1976	0.9	65.2	66.6
1977	negl.	19.7	19.7
1978	negl.	6.7	6.7
1979		6.8	6.8
1980		11.1	11.1
1981		8.9	8.9
1982		24.2	24.2
1983		8.4	8.4
1984		6.8	6.8

Table 6.—Japan's herring import quotas, 1971-85.

Fiscal year[1]	Quota (1,000 t)	Fiscal year[1]	Quota (1,000 t)
1971	10.0	1979	40.0
1972	13.0	1980	42.5
1973	16.9	1981	45.0
1974	13.0	1982	54.0
1975	13.0	1983	54.0
1976	17.0	1984	54.0
1977	33.0	1985	68.0
1978	40.0		

[1]Japan's fiscal year is April through March.

The herring import quota was originally devised to protect the domestic herring fishing industry, while allowing domestic demand to be fully supplied. Because of the loss of access to herring fishing grounds, the Japanese Government found it necessary to remove the import quota system for herring roe in May 1972 to keep the traditional kazunoko market adequately supplied. The herring import quota was retained to provide some compensation to Japanese fishermen for the loss of income and jobs caused by the Japanese-Soviet agreement (and, later, by the extension of 200-mile zones in the North Pacific). Because of the high demand for herring in Japan, and the encouragement of herring producer countries interested in exporting herring to the Japanese market, the Japanese Government has gradually "liberalized" the annual herring import quota from 10,000 t in 1971, to 68,000 t in 1985 (Table 6). A further liberalization of the import quota would depend primarily on the pressures exerted both externally (by herring producer countries) and internally (by increased domestic demand) upon the Japanese Government.

Japan's herring import quota applies to live, fresh, chilled, frozen, or salted herring and covers imports from all herring trading countries. The quotas are set biannually, according to Japan's fiscal year (which runs from April to March). The Japanese Government announces half-year quotas at the beginning and middle of the fiscal year. Herring traders interested in exporting to Japan complain about the restrictive import quota system, but also point out that a "second dimension" to the import quota, which requires that all herring imports be licensed, is probably a more serious trade obstacle than the quota itself. For example, the Japanese Government granted import quota licenses to only the Hokkaido Federation of Fishery Cooperative Associations (Dogyoren) from 1977 to 1980. This group had little interest in importing processed herring, as its membership includes herring fishing vessel owners as well as processors. In 1980, U.S. fishery trade representatives asked the Japanese to distribute herring import quota licenses to other associations and companies besides Dogyoren. The Japanese Government agreed to assign a percent of the total 1980 licensed import quota to a processor's cooperative (Do Kakoren - the Federation of Hokkaido Fish Pro-

Table 7.—Japan's herring tariffs, by commodity, 1985.

Commodity	Tariff[1]	
	GATT	Non-GATT
Herring		
Fresh	10.0	10.0
Frozen	6.5	10.0
Fillets	10.0	10.0
Salted	15.0	15.0
Smoked	15.0	15.0
Canned	9.0	20.0
Herring roe		
Fresh	8.3	10.0
Frozen	6.0[2]	10.0
Cured	12.0[2]	15.0
On tangles	5.0	15.0
Canned	16.0[2]	20.0

[1]Percentage (ad valorem).
[2]Temporary tariff. The tariffs for these commodities had not yet been reduced officially to these levels.

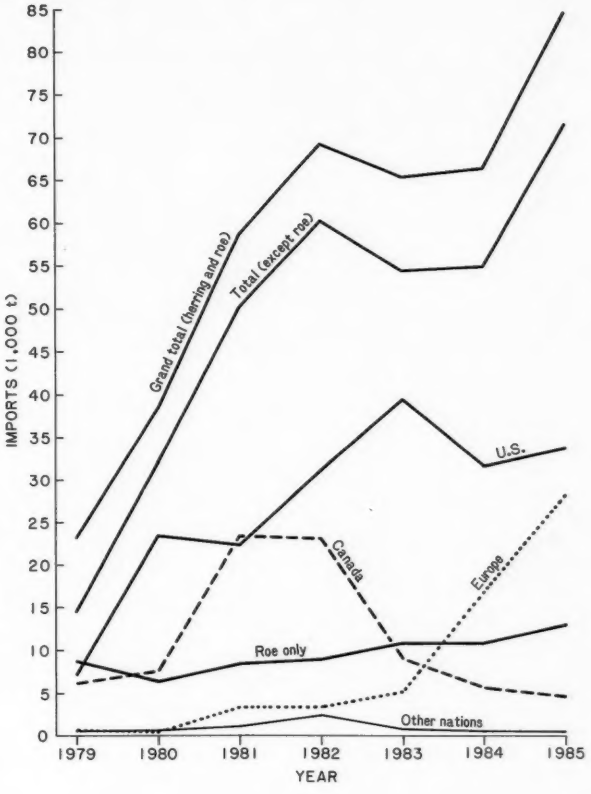


Figure 1.—Japan's herring imports by source and quantity and roe imports by quantity, 1979-84.

cessors Association). In 1981, the Japanese Government further relaxed the criteria of eligibility to import herring and about 26 Japanese processing associations and trading firms currently receive licenses to import herring. Dogyoren still dominates the herring quota system as it receives about 50 percent of the import licenses. The remainder is divided among the other 25 processing associations and trading companies.

Tariffs

The Japanese Government imposes tariffs on herring commodities in addition to the quantitative restraints on herring imports. Japan has no need for such tariffs as revenue measures, their purpose is to protect the domestic market. Some trade observers note that if Japan desires to protect its herring market, the import quotas already in place provide more than adequate protection. Japan was urged by other nations to reduce various fishery tariffs during the "Tokyo Round" of the General Agreement on Tariffs and Trade (GATT) Multilateral Trade Negotiations in 1979. The Japanese made concessions to gradually reduce ad valorem duties for frozen herring roe and round herring and herring fillets from 10 to 6 percent during 1979-87[1]. By 1985, tariffs were reduced for frozen herring roe and round herring to 6 and 6.5 percent, respectively, but the Japanese have failed to reduce herring fillet duties whatsoever. Other tariffs for herring commodities range from 8.3 to 20 percent (Table 7). Japan may be urged to reduce further fishery tariffs—including those for herring commodities—when the next round of GATT negotiations begin to take place in late 1986 or 1987.

[1]These tariff reductions were only for GATT signatory nations; other nations may face higher tariffs.

Commodities

The Japanese import almost a dozen different herring commodities; Table 7 illustrates the varying tariffs that are placed on those commodities by the Japanese Government. A precise picture of Japan's herring imports cannot be determined as shipments of processed commodities, such as smoked, canned, and filleted herring, are included in "basket" categories with other fish species in Japanese statistics. Nevertheless, a fairly good overview of Japan's herring imports can be made, as restrictive tariffs limit shipments of smoked, canned, and filleted herring. Because there is a difference between the marketing of round herring (a common foodstuff) and herring roe (a traditional delicacy), these two commodity groupings are usually analyzed separately from each other. While the quantity of Japan's round herring imports accounted for over five times those of herring roe during 1980-85, the value of Japan's lucrative herring roe imports during the same period have consistently exceeded round herring import values by about 40-45 percent (Table 8).

Table 8.—Japan's round herring and herring roe imports, by value, 1979-85, in millions of U.S. dollars.

Year	Herring		
	Round[1]	Roe	Total
1979	24.2	256.0	280.2
1980	49.1	83.5	132.6
1981	67.4	115.5	182.9
1982	75.7	124.3	200.0
1983	83.0	148.1	231.1
1984	69.1	125.9	195.0
1985	109.1	189.7	298.9

[1]Includes roe bearing herring.

Round herring

The Japanese primarily import frozen round herring; small quantities of fresh and salted herring are also imported, but they face higher duties than the frozen herring. An undetermined amount of Japan's frozen herring (mostly Pacific) imports consist of roe herring that is destined for roe removal by Japanese processors. Because the Japanese Government has lowered the frozen herring tariff while increasing the herring import quota during 1979-85, the Japanese market has absorbed greater quantities of herring shipments from the United States, Canada, and Europe. Japanese importers, for example, increased purchases from only about 14,500 t of herring worth $24 million in 1979, to nearly 71,800 t worth $109 million during 1985 (Tables 1 and 2).

Herring roe

Japan's imports of Pacific and Atlantic herring roe consist of both frozen and cured roe. Some of the imported frozen roe is destined for curing or flavoring by Japanese processors before reaching consumers, while imported cured roe has already undergone a drying, salting, smoking, or bleaching process. Frozen roe imports have accounted for a larger share of Japan's total roe imports in recent years. For example, imported frozen roe accounted for only 6 percent of the total quantity of roe imports in 1979, while almost 30 percent of Japan's total roe imports consisted of frozen roe in 1984. This increase is mostly due to an increased shipment of frozen Atlantic herring roe by Canadian and European exporters to Japanese processors.

The most valuable of the Japanese herring roe commodity imports is cured Pacific herring roe on sea kelp, which is known as "komuchi konbun". The United States and Canada are Japan's only suppliers of herring roe on kelp. Some imported shipments of komuchi konbun have been valued at over $20,000/t in recent years.

Sources

The Japanese import herring and herring roe from various countries, and the United States and Canada are the leading herring commodity suppliers to the Japanese market. In recent years, Japanese importers have purchased greater quantities of herring from European sources—most notably Norway—because European herring stocks have been recovering from overfishing that occurred during the 1960's and 1970's (Fig. 1). Because the demand for herring has been satisfied in Europe by the increased Atlantic herring harvests, European exporters have capitalized upon Japan's increased herring import quotas and decreased tariffs. For example, frozen European herring shipments to Japan increased from only 600 t (worth $0.7 million) in 1979, to nearly 32,100 t (worth $27.2 million) during 1985 (Tables 1 and 2). Similarly, European herring roe shipments to Japan increased from only 14 t (worth $42,800) to 940 t (worth nearly $5.0 million) from 1979 to 1985 (Tables 3 and 4).

Round Herring

The United States is the leading supplier of herring to the Japanese market and U.S. herring shipments have accounted for nearly 60 percent of Japan's total supply of imported herring (fresh, frozen, and salted) during 1979-85. The U.S. shipments consist entirely of Pacific herring, *Clupea harengus pallasi*, which is mostly harvested in Alaskan waters. Almost all of the herring shipped by U.S. exporters consists of roe herring destined for roe removal and further processing in Japan. The Japanese also purchase U.S.-harvested roe herring though a joint venture in Bristol Bay, Alaska. The 1981-85 purchases were: 1981, 953 t; 1982, 2,453 t; 1983, 2,632 t; 1984, 3,230 t; 1985, 2,371 t. This joint venture was begun in 1981, but observers are not sure that it would continue beyond 1986. The United States exported a record-high quantity of herring to Japan in 1983, when over 38,000 t worth $70.5 million were purchased by Japanese companies. During 1985, the Japanese purchased nearly 34,100 t of frozen U.S. herring worth $77.0 million.

Canada is also a major supplier to the Japanese herring market, and Canadian exporters ship both Atlantic and Pacific herring to Japan. Unlike the United States, about 95 percent of Canada's frozen herring shipments to Japan consist of Atlantic herring rather than Pacific because regulations enacted by the Canadian Government limit the amount of Pacific roe herring shipments to only 5 percent of the total annual harvest, because the added value of extracting herring roe benefits Canadian processing companies. This regulation is not applicable on Canada's east coast because there has never been a roe fishery for Atlantic herring. Besides, Atlantic herring roe is not as highly valued as Pacific herring roe.

Canadian herring shipments to Japan have decreased in recent years, despite the Japanese liberalization of herring import restrictions, for several reasons. Competition from European herring exporting countries has cut into Canadian exports to Japan. The Canadians accounted for 23,450 t (worth $24 million) or 47 percent, of the quantity of Japan's herring imports in 1981, but during 1985, Japanese purchases of Canadian herring amounted to 5,100 t (worth almost $4.5 million) or only 7 percent of the total quantity of Japanese herring imports.

The most dramatic increase in Japan's herring imports has been the increasing amount of frozen herring shipments from European sources; most notably Norway, the Netherlands, and Sweden. These countries have not only benefited from the increase in the Japanese herring import quota and decrease in frozen herring tariff, but favorable exchange rates and the fact that formerly depressed northeast Atlantic herring stocks (and catches) have increased, enabling the Europeans to capitalize upon the strong demand for herring in Japan. The increased European herring shipments to Japan have intensified competition for Canadian (east coast) exporters more than for U.S. exporters, because of the

higher demand for Pacific roe herring in Japan, rather than for Atlantic roe herring.

Among Japan's European herring suppliers, Norway has made the greatest inroads in shipping herring to the Japanese market. Norwegian herring shipments amounted to only 8 t (worth $9,000) in 1982, but have increased to 18,500 t (worth $18.7 million) during 1985. Much of the increase results from an active marketing campaign in the Japanese market by the Norwegians. In March 1985, Norway's Minister of Fisheries led a 19-member delegation to Japan, consisting of representatives from the Norwegian Export Council and the Herring Export Council, seeking to increase Norwegian fishery exports—especially herring exports—to Japan. Since then, scientists at Norway's Institute of Fishery Technology Research have developed equipment capable of sorting female (with roe) from male herring. Observers believe that this new technique will have a considerable effect on the price that Norway gets for its herring on the Japanese market where buyers are willing to pay up to 100 percent more for females (roe) herring than for an unsorted consignment. Because the herring quotas agreed upon by the European countries for the northeastern Atlantic were enlarged for 1986, observers believed that European herring shipments to Japan—especially those from Norway—would increase.

Herring Roe

Japan obtains most of its imported herring roe from Canada (Tables 3 and 4). Except for 1980 (the year after the collapse of the Japanese herring roe market), Canada's herring roe shipments have amounted to well over half of Japan's supply of imported herring roe and an average of over 60 percent of Japan's herring roe imports during 1979-85. Most of Canda's shipments consist of the more valuable Pacific herring roe, although Japanese importers have recently begun to purchase increasing amounts of Atlantic herring roe. While the Pacific herring roe is mostly imported to supply the annual shogatsu demand, the Atlantic herring roe is consumed during a year-round market and is served as an appetizer. The most highly priced Canadian herring roe commodity exported to Japan is the herring roe on kelp. Shipments during 1985 amounted to 209 t, valued at $6.0 million.

The United States is Japan's second largest supplier of herring roe. U.S. shipments consist almost entirely of cured Pacific herring roe; less than 1 percent of U.S. herring roe shipments to Japan consists of frozen product. The United States, like Canada, also ships herring roe on kelp to the Japanese market. Total Japanese purchases of all U.S. herring roe commodities during 1985 amounted to nearly 1,690 t worth $32.7 million.

European herring roe exports to Japan are only a small fraction of Canadian and U.S. shipments, but they have steadily increased in recent years and the Europeans are making inroads into the Japanese market. The European Atlantic herring roe does not currently have a major effect upon the shogatsu herring roe market, which is traditionally supplied by U.S. and Canadian Pacific producers, although it may in years to come. The European herring roe presently competes heavily with Canadian Atlantic herring roe in the year-round appetizer market in Japan. The primary European supplier of frozen Atlantic herring roe to the Japanese market is Ireland, while Denmark accounts for most of Japan's cured herring roe coming from Europe. Total European shipments of herring roe commodities to Japan during 1985 amounted to 940 t worth $5 million.

A distinct possibility exists that Atlantic herring roe may directly compete with Pacific herring roe in the highly valued shogatsu market in the future. Biologists have observed that the ovaries and the eggs of the two species are almost identical physiologically and that the taste, texture, size, and oil content of Atlantic roe has the potential of equalling Pacific roe, provided that North Atlantic fishermen can harvest the Atlantic herring during the same critical spawning time that coincides with the Pacific herring roe fishery. The only factor which currently prevents this is that most Atlantic herring spawn well below the surface of the ocean, while Pacific herring tends to spawn near the ocean surface in coastal waters, thus making it difficult for fishery biologists to predict a precise optimal harvesting period to obtain marketable roe. This obstacle may possibly be overcome in the future as biologists and fishery technologists are able to develop precise predictions when marketable Atlantic roe herring stocks are spawning.

Japan also obtains small quantities of Pacific herring roe from countries such as China, the Republic of Korea (ROK), the Soviet Union, and North Korea. Japanese herring roe imports from these countries have accounted for about 13-14 percent of Japan's total herring roe imports since 1982. Almost all of the processed Pacific herring roe that Japan obtains from China and the ROK is from North American-origin roe herring (mostly from the United States) that was imported by those countries for roe removal and curing and reexported to Japan. Observers report that some Japanese companies have transshipped roe herring from the United States to China for processing into cured herring roe. The Japanese were reportedly able to utilize inexpensive Chinese labor while using the herring carcasses as partial payment for the roe removal and curing services rendered by the Chinese.

The Soviet Union, China, and North Korea have the potential to increase herring and herring roe sales to Japan, but their exports are currently hindered by higher tariffs than those faced by the United States, Canada, and European countries because these Communist countries are not GATT membernations and, therefore, often face a separate tariff schedule which assesses higher duties than for GATT membernations for certain herring commodities. In addition, because China and North Korea are at the extreme end of the range of Pacific herring, harvestable quantities of spawning herring occur only sporadically. Herring and herring roe shipments from the Soviet Union may increase in the future, despite the fact that shipments may face high tariffs, because stocks are reportedly increasing in the Sea of Okhotsk and the Soviets may be willing to undercut Canadian and U.S. prices for herring commodities in Japan to earn hard currency.

Development of the Moroccan Fisheries

The 200-vessel Moroccan high-seas fishing fleet lands its catch almost entirely in Las Palmas, a port in the Spanish Canary Islands. The Moroccan Government and private companies are both investing large sums in port infrastructure and fish freezing and processing facilities to entice the fleet back from Las Palmas to Moroccan ports. This new investment in the ports of Tan Tan and Agadir, however, will not automatically remove the economic incentives favoring Las Palmas. Moroccan officials talk of voluntary gradual repatriation of the fleet, but the Government may find itself compelled to offer incentives and bring financial and/or legal pressure to bear on vessel owners to induce the high-seas fleet to land its catch in Moroccan ports. The ensuing realignment of markets could provide opportunities for U.S. seafood firms interested in joint ventures.

"Moroccanization"

Over the past decade, Morocco has been engaged in a determined campaign to "Moroccanize" the utilization of the rich fishing grounds off southern Morocco and the Western Sahara. In 1981, the Government extended its economic zone to 200-nautical miles. A 4-year Spanish-Moroccan fisheries agreement, signed in August 1983 and to be renegotiated in August 1987, provides for a progressive decrease of Spanish catch quotas and a concomitant increase in Spanish assistance to Morocco and in the Moroccan share of the catch. The Spanish Government agreed to provide, over the 4 years of the agreement, more than $550 million in assorted credits (25 percent of which at concessional rates of interest) for the development of Moroccan fisheries. The Moroccan Government has provided generous financial incentives to Moroccan vessel owners, largely funded by these Spanish loans. The net result of Morocco's policies has been the growth of a Moroccan-owned (or partnered) high-seas fleet of some 200 trawlers to compete with the Spanish, Japanese, and Portuguese fleets still fishing legally in Moroccan waters[1].

Las Palmas Landings

In 1984, the Moroccan high-seas fleet landed 77,000 metric tons (t) of whitefish and cephalopods. The vast majority of the catch was landed in Las Palmas. Of that amount, 34,000 t was exported to Europe, 31,700 t to Japan, and 11,700 t to African countries. The total value of the high-seas landings was estimated at 934 million dirhams (US$88.1 million)[2]. Large cephalopods (octopus, cuttlefish, and squid), exported to Japan, were the most valuable product.

Until 1985, Morocco did not possess a port with the necessary maintenance facilities to act as homeport for large freezer trawlers. Morocco's high-seas fleet, based primarily in Las Palmas, sells frozen fish to European and Japanese middlemen. Much of the hard currency earned stays in Las Palmas to pay for diesel oil and spare parts, and for maintenance and shore services. Not only is the Moroccan Government concerned about the foreign exchange loss, but Moroccans are deprived of the opportunity to add value through processing and packaging.

Over the past 3 years the Government and private enterprise have mobilized considerable investment to remedy the lack of homeport infrastructure. The Ministry of Equipment budgets funds for port construction and expansion, but fish handling, cold storage, and ship repair facilities depend on private investment.

Tan Tan and OMP

In 1978, a Casablanca businessman, Mohamed Laraki, established the Omnium Marocain de Peche (OMP)[3] company in partnership with an Arab expatriate residing in France. OMP has used about US$80 million in government-guaranteed[4] French and Spanish credits to buy 27 freezer trawlers of 328 t each (US$30 million) and to construct a fishing complex at Tan Tan (US$50 million). Located about 400 km south of Agadir, Tan Tan is a prosperous population center on the Moroccan side of the former boundary with the Spanish Sahara. Finished in the spring of 1985, the Tan Tan port was designed to take advantage of the rich nearby coastal resources to supply a gleaming high-technology fish processing plant (100 t a day processing capacity), a freezing plant (100 t a day), a cold store (5,000 t holding capacity), and a fishmeal plant (150 t of fish a day reduction capacity). In addition, OMP has shore facilities to support the company's 27 freezer trawlers as well as vessels owned by other companies. This enormous investment has been nearly idle—OMP buys sardines from the coastal fleet for freezing or reducing into fishmeal, but the whitefish and cephalopd landings are insufficient for the operation of the fish-processing plant so long as the Moroccan high-seas fleet remains in Las Palmas. Local fishermen currently truck frozen sardines up to the packing plants of Agadir and Safi (a day's ride in open truck through the desert).

Agadir

In 1984, the Agadir fishing fleet of 205 coastal vessels landed 176,324 t of fish, a small decline from 1983. The area of the existing port is small and cannot be expanded. The Ministry of Equipment is using Spanish Government credits (from the bilateral fishing

[1]The U.S.S.R. has a treaty of technical cooperation with the Government, but no fishing rights; extensive illegal Soviet fishing has been assumed but most of the vessels intercepted and fined are Spanish-owned.

[2]Based on the January 1986 exchange rate of 10.6 dirhams to the U.S. dollar.

[3]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

[4]The loans are guaranteed by Morocco's Caisse Centrale de Garantie.

agreement) to build a new cargo port half as large as the old, to be finished in 1989.

Las Palmas Advantages

Even the OMP fleet of 27 freezer trawlers has been in no hurry to leave Las Palmas. In part, this hesitation reflects the Government's sluggishness in obtaining the vital spare parts inventory needed to support the fleet. More important though are Las Palmas' formidable economic advantages. A large, completely equipped port, Las Palmas is actually located nearer the richest fishing grounds than either Tan Tan or Agadir. Even when the Moroccan Government makes a long-promised move to offer diesel fuel in Tan Tan and Agadir at the prevailing international prices, Las Palmas will retain the equally decisive advantage of direct access to established international markets. Intangibles favoring Las Palmas include not only social amenities for still largely non-Moroccan crews (Tan Tan is a desert outpost), but also freedom from close Government of Morocco enforcement of catch restrictions and currency repatriation regulations.

Fleet Transfer

Though both the OMP and the Fisheries Ministry deny that the Government will act unilaterally to compel the fleet to return, a convincing program of economic incentives for the fleet to transfer voluntarily has not been worked out. Moroccan officials foresee repatriation as a gradual process, beginning in 1986. The entire fleet cannot be accommodated until after the completion of Agadir's new port. OMP maintains that lower costs in Tan Tan for allegedly equal or superior service, combined with the benefits of reduced hard currency outflow, will suffice. The Ministry talks vaguely of "encouragement" for vessel owners.

Even though its operation in Tan Tan was not fully underway, the OMP seemed confident and was planning to double cold storage capacity to 10,000 t. Meanwhile, the Government was planning a US$12 million project to improve poorly designed port access, as well as the installation of a large new water-desalinization plant for the port. In light of this confidence, it may be that a program of incentives and pressures is in the works. A change in foreign exchange controls or customs regime may make Tan Tan more attractive.

To be successful, the transfer of the fleet will require a major shift in marketing. To compete in international markets with Las Palmas, Morocco will have to become much more aggressive in marketing its own products. OMP officials talk, for example, of "coming up with a large U.S. seafood distributor to take advantage of the growing American market." The company's Tan Tan plant could be adapted to the packing of specialty frozen seafood dinners. OMP officials also contemplate a much more active role in selling fish to Africa.

A complicating factor for any investor is that the richest fishing grounds lie off the Western Sahara, in waters recognized de facto but not de jure as being under Moroccan administrative control. Pending an internationally accepted solution to the Sahara conflict, the security of investments and operations south of the old international border (just south of Tan Tan) cannot be unconditionally assumed. (Source: IFR-86/08.)

Recent Developments in Iceland Fisheries

Iceland's fish catch rose from 1.5 million metric tons (t) in 1984 to over 1.7 million t in 1985, breaking the record of 1.6 million t caught in 1979. Capelin accounted for 993,000 t worth $44 million, followed by Atlantic cod, 323,000 t valued at $134 million. The rapid growth of fresh fish exports to Western Europe have produced both profits and problems for Iceland; the amount of raw material available to Iceland's seafood processing industry, the backbone of Iceland's economy, had been reduced, thereby threatening jobs and the maintenance of steady shipments of processed fishery products to established markets.

While freezing will continue to be the major export earner in Iceland, there is concern about the loss of foreign markets, especially in the United States. The United States remained Iceland's most important customer in 1985, purchasing $202 million worth of Icelandic seafoods, mostly frozen fish. There is some concern about the decline in the value of the U.S. dollar and its possible effect on the profitability of Icelandic exports in the future.

The Icelandic capelin (*Mallotus villosus*) is a small fish that inhabits the Arctic waters off Iceland and eastern Greenland. Because of its abundance and pelagic schooling nature, the capelin is a major food resource for larger marine species. During the past two decades capelin has replaced herring as the main raw material for Iceland's fishmeal and oil producers. About 50 Icelandic purse seiners currently fish for capelin.

As noted, in 1985, Icelandic fishermen caught a record 993,000 t of capelin. Iceland shares the capelin resource with Norway and Greenland under a quota system: Iceland takes 85 percent of the total quota, Norway takes 15 percent, and the remaining 5 percent is issued to Greenland. Greenland's fishing community is demanding that their share be increased from 5 to 40 percent, a claim which is being disputed by Iceland and Norway.

Iceland's capelin meal and oil is produced in old reduction plants built to process herring. The chief markets for capelin meal include the United Kingdom (UK), Finland, and West Germany. Capelin oil is mostly sold in the U.K. The U.S. Embassy in Reykiavik has prepared a 19-page report reviewing Iceland's capelin resource, catch, quota system, production of capelin meal and oil, and marketing efforts. The report includes statistical tables on both catch and production. U.S. companies can obtain a copy of "Iceland's Capelin Fishery, 1985" for $9.95 and a $3.00 handling fee (total $12.95, personal checks or money orders only) by ordering report PB86-246014/6BA from NTIS, Springfield, VA 22161. Also available from NTIS is an 11-page report titled "Icelandic Fisheries, 1985-86" for $9.95 and a $3.00 handling fee (total $12.95, personal checks or money orders only) by ordering report PB86-235041/GBA.

The Fisheries of Latin America

Latin American fishermen reported significant catch increases in 1985, and all major fishing countries reported improved results. Preliminary reports suggest that Latin American fishermen caught about 13.9 million metric tons (t) in 1985, a 16 percent increase over the 12.0 million t taken in 1984 (Fig. 1). Many countries in the region have implemented significant fishery development programs. Officials in those countries have assigned a high priority to fisheries because they see it as an industry which can both provide high-protein food to domestic consumers and also produce important foreign exchange earnings. Fishery products are one of the most important nonpetroleum export earners for nearly half of the Latin American countries.

Grounds

Latin American countries conduct fisheries on grounds as diverse as the frigid waters off Patagonia and the tropical waters of the Caribbean. Upwelling and the northerly flowing Peruvian Current produce one of the world's most productive fishing grounds off the coasts of Chile and Peru, primarily for various pelagic species. An extensive shelf area and the Falklands/Malvinas Current produce another important fishing ground off the coast of Argentina, primarily for squid and various demersal fish.

On the more northerly grounds off Brazil, Ecuador, and Mexico important fisheries are conducted for shrimp, lobster, tuna, and other tropical species. Local observers believe that many Latin American countries could significantly expand their current fishery catch. One FAO study suggests that the Latin American catch could be increased by 7-8 million t with existing technology. For example, fishermen have only recently initiated extensive fisheries to utilize the rich resources of the Patagonian shelf. Most of the catch there is being taken by distant-water fishermen, particularly Polish, Soviet, Spanish, and Japanese fishermen.

The countries in the region reported continued recovery from the 1982-83 El Niño event in the Eastern Pacific, one of the most devastating such events ever recorded. The 1985 catch was the largest Latin American catch reported since the collapse of the Peruvian anchovy fishery in 1972. Disregarding anchovy, catches in the region set new record levels in 1985 (Table 1, Fig. 1). Latin America has experienced more severe fluctuations in its fisheries than any other world region. Most of these fluctuations have resulted from sharp changes in one fishery—Peru's anchovy fishery. If the Peruvian anchovy catch is deleted from the regional totals, the Latin American fisheries catch has been generally stable at 8.6-9.6 million t between 1979 and 1983. Following the 1982-83 El Niño, however, several countries have reported major catch increases, especially Chile, Ecuador, and Peru. As a result, the total regional catch increased to over 12.0 million t during 1984 and 1985.

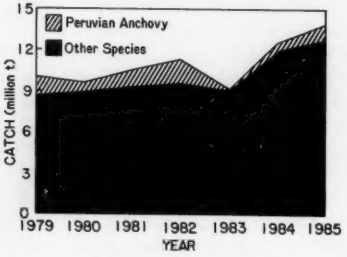


Figure 1.—The Latin American fisheries catch, 1979-85.

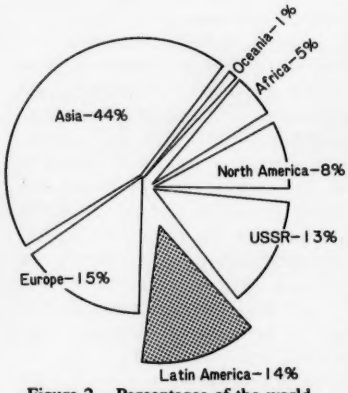


Figure 2.—Percentages of the world fisheries catch by region, 1984 (total = 83.2 million t).

Latin American fishery officials believed that the 1986 catch would be as large or even larger than the 1985 catch, but actual results may be strongly affected by two factors: Developments in Chile and Peru, the region's two major fishing countries, will have a major impact on year-end results for the region as a whole. Chilean officials closed the huge northern pelagic fishery in December 1985 and January 1986. Chilean catches, however, have continued to expand and may set another new record in 1986.

And, Peruvian officials were reporting catches slightly above 1985 levels. Anchovy stocks in particular had apparently continued to recover from the effects of the 1982-83 El Niño.

The Latin American 1985 fisheries catch of 13.9 million t amounted to 17 percent of the 84.0 million t caught world wide by all countries (Table 2). The latest available comparative data for all world regions is 1984 (Table 2 and Fig. 2). The Latin American catch exceeded the Soviet catch in 1984 and, the NMFS Branch of Foreign Fisheries Analysis believes, probably exceeded the European catch in 1985, making Latin America the world's second most important fishing region. Only the massive Asian catch is believed to have exceeded the Latin American catch. While

Table 1.—Latin America's fisheries catch, 1980-85.

Country or Dependency	Catch (1,000 t) 1980	1981	1982	1983	1984	1985[1]	Major species
Caribbean							
Antigua	1.6	1.8	2.0	2.2	2.2F	2.2F[2]	
Bahamas[3]	5.0	4.4	4.7	5.2	5.3	8.2	Lobster
Barbados	3.7	3.4	3.5	6.5	6.5F	6.5F	
Bermuda[3]	4.1	2.0	2.2	0.5	0.5F	0.5F	
British Virgin Isl.	0.3F	0.3F	0.3F	0.3F	0.3F	0.3F	
Cayman Islands	0.5F	0.7	0.8	0.7	0.6F	0.6F	
Cuba	186.5	164.8	195.2	198.5	199.6	219.9	Lobster
Dominica	1.4	1.5	1.5	1.0F	0.4F	0.4F	
Dominican Republic	10.7	12.0	13.2	13.2F	13.2F	13.2F	
Grenada	1.8	1.7	1.8	0.6	0.6	0.6	Flying fish
Guadeloupe	8.0F	8.3F	8.2F	8.8F	8.9F	8.9F	Mackerel
Haiti	4.1F	4.1F	4.2F	4.3F	4.4F	4.4F	
Jamaica	9.1	7.8	7.9	8.7	9.6	9.6F	
Martinique	5.0F	4.7F	5.5F	5.1F	5.2F	5.2F	
Montserrat	0.1F	0.1F	0.1F	0.1F	0.1F	0.1F	
Netherlands Antilles	1.9F	1.8F	1.8F	1.8F	1.8F	1.8F	
Puerto Rico	2.6	2.7F	2.2	2.5	2.3	2.3F	
St. Kitts	1.9	1.9	1.9	1.1	1.1F	1.1F	
St. Lucia	2.4	2.4	2.4	2.6	2.6F	2.6F	
St. Vincent	0.5F	0.5F	0.5F	0.5F	0.5F	0.5F	
Trinidad-Tobago	4.5	3.8	4.6	4.2	3.6	3.6F	Mackerel
Turks and Caicos	1.1F	1.1F	1.1F	1.1F	1.1F	1.1F	Lobster/conch
U.S. Virgin Islands	0.7	0.6	0.9	0.6	0.7	0.7	
Total	257.5	232.4	266.5	270.1	271.1	294.3	
Central America							
Belize	1.3	1.3F	1.4F	1.5F	1.6F	1.6F	Lobster/conch
Costa Rica	18.3	15.0	10.9	9.2	12.0	12.0F	Shrimp
El Salvador	14.0	20.3	13.5	7.6	12.2	12.2F	Shrimp
Guatemala	3.5	4.3	4.3	2.4	3.0	2.7	Shrimp
Honduras	6.4	6.3	5.0	8.4	8.4	8.4F	Lobster
Mexico	1,222.5	1,536.2	1,321.0	1,064.3	1,103.7	1,300.0	Shrimp/tuna
Nicaragua	7.0	5.9	5.0	4.5	4.3	4.3F	Shrimp/lobster
Panama	216.4F	149.5F	116.6F	169.4F	138.2F	251.1F	Shrimp/anchovy
Total	1,489.4	1,738.8	1,477.7	1,267.3	1,283.4	1,592.3	
South America							
Argentina	385.3	361.5	475.0	416.4	314.2	386.6[4]	Hake/shrimp
Bolivia	4.4	5.6	5.6F	5.6F	5.6F	5.6F	
Brazil	819.8	828.7	828.9	875.4	954.4	1,020.0	Shrimp/lobster
Chile	2,816.7	3,385.4	3,673.0	3,981.8	4,499.3	4,804.4	Sardine/mackerel
Colombia	76.2	94.7	71.4	57.5	78.5	69.0	Shrimp
Ecuador	643.5	731.0	654.1	307.3	867.5	1,647.9	Shrimp/tuna
French Guiana	1.2	1.4	2.0	2.5	2.5	2.5F	Shrimp
Guyana	23.6	23.4	25.8	27.6	32.4	32.4F	Shrimp
Paraguay	3.3F	3.4F	3.4F	3.5	5.0	5.0F	
Peru	2,738.6	2,741.2	3,528.6	1,568.3	3,317.5E	3,594.2	Sardine
Suriname	3.0	3.4	2.9	3.6	4.1	4.1F	Shrimp
Uruguay	120.4	147.0	119.1	144.1	134.0	140.0	Hake/croaker
Venezuela	186.6	191.9	213.7	217.0	254.4	282.8	Shrimp/tuna
Total	7,822.6	8,518.6	9,603.5	7,610.6	10,469.4	11,994.5	
Grand total[5]	9,569.5	10,489.8	11,347.7	9,148.0	12,023.9	13,881.1	

[1]1985 data are available only for major countries. For other countries, 1984 data were used to obtain the totals and an indication of general trends.
[2]F = Estimated by FAO.
[3]These islands are not physically located in the Caribbean, but are included in the Caribbean totals for organizational simplicity.
[4]Different Argentine sources provide sharply different 1985 catch estimates, varying from 330,000-387,000 t. FAO reports a catch of 407,000 t.
[5]NMFS has followed the FAO system of excluding seaweed which in the case of some countries requires that their official statistics be adjusted. Such adjustments can be significant, Chilean seaweed harvests, for example, totaled 182,000 t in 1985.

Table 2.—World fisheries catch by region, 1980-85.

Region	Catch (million t) 1980	1981	1982	1983	1984	1985
Asia	30.9	32.3	33.1	35.0	37.0	
Europe	12.5	12.5	12.1	12.5	12.8	
Latin America	9.6	10.5	11.3	9.2	12.0	13.9
U.S.S.R.	9.5	9.5	10.0	9.8	10.6	
North America	5.0	5.2	5.4	5.5	6.4	
Africa	4.1	4.3	4.1	4.4	4.0	
Oceania	0.4	0.4	0.4	0.4	0.5	
Total[1]	72.0	74.9	76.6	76.8	83.2	84.0

[1]Totals may not agree due to rounding.

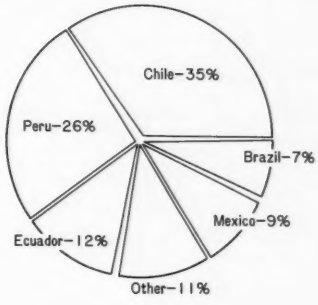


Figure 3.—The Latin American fisheries catch, 1985 (total = 13.9 million t).

Latin American fishermen will never approach the massive Asian catch, they are likely to continue their lead over European and Soviet fishermen who are currently fishing extensively off their own coasts and who are having increasing problems with access to distant-water grounds. Many Latin American countries, on the other hand, have sizeable coastal stocks which they are not fully utilizing.

Major Countries

Latin American fisheries are dominated by the large catches of two countries—Chile and Peru. Those two countries reported a combined catch of over 8.4 million t, over 60 percent of the fish and shellfish taken in the region during 1985 (Table 1 and Fig. 3). The most important 1985 developments in the six largest Latin American fishing countries are given below.

Chile

Chile is Latin America's most important fishing country (Table 1). Chilean fishermen have steadily increased their catch since 1977. Unlike neighboring Peru, the Chilean catch was not reduced by the massive 1982-83 El Niño event, although some specific fisheries were affected. Fishermen reported major catch increases in both 1984 and 1985. The record 4.8 million t taken in 1985 ranks Chile as the world's fifth most im-

Table 3.—Catch of the major fishing countries of the world, 1980-85.

Country	Catch (million t)					
	1980	1981	1982	1983	1984	1985
Japan	10.4	10.7	10.8	11.3	12.0	11.5F[1]
U.S.S.R.	9.5	9.5	10.0	9.8	10.6	10.3
China	4.2	4.4	4.9	5.2	5.9	NA[2]
U.S.A.	3.6	3.8	4.0	4.1	4.8	5.0
Chile	2.8	3.4	3.7	4.0	4.5	4.8
Peru	2.7	2.7	3.5	1.6	3.3	3.6
India	2.4	2.4	2.4	2.5	2.9	2.8
Korea (ROK)	2.1	2.4	2.3	2.4	2.5	2.7
Indonesia	1.8	1.9	2.0	2.2	2.2	NA
Norway	2.4	2.6	2.5	2.8	2.5	2.1
Thailand	1.8	2.0	2.1	2.3	2.2	2.1
Philippines	1.6	1.7	1.8	2.0	1.9	2.0
Iceland	1.5	1.4	0.8	0.8	1.5	1.7
Denmark	2.0	1.9	1.9	1.9	1.8	1.7
N. Korea	1.4F	1.5F	1.6F	1.6F	1.7F	1.7F
Ecuador	0.6	0.7	0.7	0.3	0.8	1.6
Canada	1.3	1.4	1.4	1.3	1.3	1.4
Spain	1.3	1.3	1.4	1.3	1.3	1.3
Mexico	1.2	1.5	1.3	1.1	1.1	1.3
Brazil	0.8	0.8	0.8	0.9	1.0	1.0

[1]F = FAO estimate.
[2]NA = Not available.

portant fishing country (Table 3). Catches of the species which dominate Chilean landings (sardines and mackerels) increased by 11 percent in 1985. The only major species groups which declined were crustaceans.

Chilean scientists are concerned about the long-term impact of the explosive growth of Chilean fisheries, especially on sardine stocks. To protect those stocks, the Chilean Government closed the reduction fishery on 14 December 1985, and did not reopen it until the end of January 1986. Chilean companies have made major investments in recent years adjusting to the decline of anchovy stocks. The companies redirected their fishing effort to sardine and mackerel stocks. These companies have made the necessary changes in vessels, gear, and strategy with little or no assistance from the Chilean Government. Many vessels, added to Chile's growing fleet, have been used vessels bought from the hard-pressed fishermen of neighboring Peru.

The Chilean fishing industry is centered in the north and is primarily concerned with the reduction of small pelagic species into fishmeal and oil. Over 80 percent of the Chilean catch is reduced and Chile is now the world's largest fishmeal exporter. Fish and shellfish taken for human consumption are harvested mostly by artisanal fishermen using traditional gear and methods. The Government is promoting the modernization and diversification of the industry and several interesting programs are underway, including demersal trawling off the southern coast, surimi production, krill fishing (joint ventures with the Japanese), and various salmon and mollusk culture projects. The two most promising programs are salmon culture and surimi production. A growing number of private companies have begun to culture coho salmon in Chile, air shipping it fresh to the United States during the winter and early spring months when U.S. domestic salmon is not available. In 1985, Chile became the first Latin American country to export surimi. The shipments were small but could eventually become a major fishery export.

Peru

Peruvian fishermen reported a 1985 catch of 3.6 million t, nearly 10 percent more than the 3.3 million t taken in 1984. The 1985 catch was the largest reported since 1979, ranking Peru as the world's sixth most important fishing country. Small pelagic stocks, especially anchovy, were reportedly recovering from the 1982-83 El Niño event and Peruvian officials were predicting major catch increses in 1986 and 1987. While many fishery stocks are at their highest level in recent years, the country's fishing industry is still recovering from the 1982-83 El Niño and associated climatic and meteorological disturbances which caused widespread destruction in coastal communities. Piers and other shore installations, as well as roads and bridges needed to transport the catch, were severely damaged.

Unlike Chilean fishermen, however, Peruvian fishermen have not made the changes necessary to utilize the much larger mackerel stocks now found in the Eastern Pacific. Peru's Instituto del Mar believes that the mackerel biomass may be as high as 9 million t. Those stocks are now being fished by the Soviet Union and other communist countries outside Peru's and Chile's 200-mile zone. The Peruvian Government is attempting to gain some economic advantage from the foreign activity and increase the supply of edible fish by pursuing negotiations to revise now-expired joint ventures with the Soviets. In addition, Peru also began in December 1985 a test fishing program with Cuba.

Peru's fishing industry is still dominated by the fishmeal industry which was nationalized in 1973. Since the nationalization, the Ministry of Fisheries has had to finance massive budget deficits (reportedly exceeding $100 million by 1985) amassed by the state-owned fishmeal company (PESCA PERU). The previous Fisheries Minister, Ismael Benavides, attempted to curtail unprofitable operations and carried out major staff reductions and plant closures. The new APRISTA Government, which assumed power in July 1985, reversed that policy and reopened 10 of the closed fishmeal plants. Catches have increased so that more fish is available for reduction, but it is not yet clear if fish landings are large enough to support the newly opened plants on a profitable basis, or if additional funds will be needed to subsidize their operations.

Recent increases in world fishmeal prices have greatly benefited PESCA PERU's efforts to avoid additional large deficits. Peru's canning industry continues to report serious economic difficulties caused by the weak international market for canned sardines and Government regulations which not only set the prices the fishermen receive, but also restrict fishmeal production by private companies. Some companies are reporting considerable success with a new fishery for scallops and the developing shrimp culture industry in northern Peru, although officials are concerned about both of these two fisheries. Nevertheless, scallops and shrimp have become two of Peru's leading fishery export commodities.

Ecuador

Ecuador reported the largest catch increase in the region during 1985. Its fishermen caught a record 1.6 million t, a 90 percent increase over the previous record 0.9 million t reported in 1984. Most of the increase was due to sharply higher catches of small pelagic species as the industry continued to recover from the effects of the 1982-83

El Niño which caused catches to plummet to only 0.3 million t. Tuna fishermen are also benefiting from the post-El Niño recovery and reported improved 1985 results. Exporters resumed large-scale tuna exports to the United States in 1985. Local investors purchased the large U.S.-owned INEPACA cannery in 1985.

The country's most important fishery in terms of value is shrimp, most of which is cultured. Shrimp farmers reported a serious shortage of postlarvae to stock their ponds during most of 1985. Postlarvae prices climbed to record levels and were often simply not available. Some farmers imported postlarvae and others attempted to use species not yet fully tested for pond culture. Reports suggest that a substantial number of ponds were taken out of production because of this inability to obtain postlarvae. As a result, Ecuador's 1985 shrimp exports fell below 1984 levels. Shipments to the United States, for example, were only 19,900 t, a decline of 6 percent from the 21,100 t exported in 1984.

While that decline was small in quantitative terms, it represented a loss of nearly $20 million. The postlarvae problem eased somewhat in October 1985, but the country will continue to experience periodic problems as long as it is dependent on wild sources of postlarvae. The shortage has caused an explosive growth in the number of shrimp hatcheries. More than 10 large hatcheries are currently in operation. Reports from Ecuador suggest that about 60 new hatchery projects are in various stages of planning and construction. It will probably be several years, however, before these hatcheries will supply a sizeable proportion of the approximately 20 billion postlarvae that growers need annually.

Mexico

Mexican fishermen reported a substantial catch increase. The 1985 fisheries catch totaled 1.3 million t, nearly 20 percent more than the 1.1 million t reported in 1984. Much of the increase resulted from improved small pelagic catches along the Pacific coast. Included in the 1984 total was a record tuna catch of over 85,000 t, mostly yellowfin tuna. The Government reported increased success in its efforts to develop export markets for tuna and claims to have exported over 35,000 t in 1985, an all-time record. Efforts to end the 1980 U.S. tuna embargo continued, but the embargo remained in place throughout the year, preventing shipments to the United States.

Mexico is also proceeding with the second phase of its major effort to develop the fishing industry which was begun in 1977. The current 5-year National Fisheries and Marine Resources Development Plan (1984-88) is much more modest than the original 1977-82 plan because of the country's fiscal crisis which began in 1982. Under the latest plan, the Government hopes to increase the fisheries catch to 2.5 million t by 1988. While a major expansion program is planned for the state-owned fishing company, Productos Pesqueros Mexicanos, most of the important fisheries continue to be reserved for the country's cooperative fishermen. Private investors, however, would like to see the regulations governing the cooperatives changed.

The country's Congress is reportedly close to passing a new comprehensive fisheries law which has been under consideration for over 10 years. One of the provisions of this proposed law retains the cooperatives' exclusive right to fish for eight reserved species, but allows private investors to participate in the processing and marketing of those species. This particular change has been severely criticized by some cooperative leaders. The Government estimated that the development plan should enable Mexico to increase export earnings from $570 million in 1984 to $690 million by 1988. Some observers, however, point out that long-term trends in Mexican exports are unclear.

Mexico is experiencing serious difficulties with many of its export-oriented fisheries. Shrimp is Mexico's leading fishery in terms of value. It is not yet known if Mexico could significantly expand its shrimp trawler catch. Many observers believe that shrimp stocks, especially those supporting the more important Pacific Coast fishery, are already being utilized at or near full capacity. A substantial decline in the shrimp catch occurred in 1985. Press reports suggest a significant deterioration of the country's cooperative-owned shrimp fleet, especially in the Gulf of Mexico. The principal reasons for the catch decline, however, are probably environmental/climatic factors. Statistical data is difficult to evaluate because a large quantity of shrimp is landed and marketed illegally.

Efforts to launch a shrimp culture industry in Mexico have not yet met with the success achieved in other Latin American countries, but Government efforts to promote the industry have been intensified and over 1,000 hectares of ponds have now been constructed. Private industry sources claim that the major factor inhibiting the industry's growth is the law which only permits marine shrimp culture to be conducted by cooperatives and ejidos. Other important export-oriented fisheries also face serious problems. Mexico continues to report difficulty exporting tuna, while catches of the two other major export-oriented fisheries, abalone and lobster, reportedly are declining.

Brazil

Brazilian fishermen significantly increased their catch in 1985, exceeding 1.0 million t for the first time. This amount was about 6 percent more than the 0.95 million t taken in 1984. About half of the catch was taken by artisanal fishermen, the highest proportion reported in any major Latin American fishing country. While the artisanal fishermen generally employ primitive methods, almost all of their catch is for human consumption. This differs from the other major Latin American fishing countries where the bulk of the catch is exported or for reduced to fishmeal and oil.

Several companies reported difficulties in 1985. Brazilian companies have a large, but poorly utilized processing capacity. Many of these companies expanded their plants using the cheap credits made available to the industry through the Government fiscal incentive program. Most of these investments were made in the processing industry

and relatively few investments were made in new vessels. As a result of this inbalanced growth, as much as 60 percent of the country's processing capacity was idle in 1985 because the fishing fleet could not deliver adequate supplies of raw material. The U.S. Embassy in Brasilia reports that the fleet is outmoded and poorly equipped to deliver the quantity and quality of fish needed by the country's modernized processing plants.

The Government announced the First National Plan for Fisheries Development (1986-89) in August 1985, but details are not yet available on the projects to be undertaken during the 4-year term of the plan. The country's two most important export-oriented fisheries are shimp and lobster. The shrimp industry can probably be expanded. The northern shrimp fishery out of the port of Belem is still not being fully utilized. Shrimp culture could also expand Brazilian shrimp production. The Government is assisting private investors entering the shrimp culture industry. Prospects for the lobster fishery are less promising. Known lobster stocks are currently being fully utilized, and any increased fishing effort could affect them adversely.

A small fishery for skipjack tuna has developed in recent years and Brazil has become a major Latin American tuna supplier to the U.S. market. The Government in 1985 attempted to end a fuel subsidy program for exporters, but the cancellation of the program was so severely criticized that it was soon restored. To diversify the fishing industry from the current dependence on shrimp and lobster fisheries, the Government began a new subsidy program that exempted fresh and frozen fish (but not shellfish) from income tax payments. Results of this program cannot yet be fully evaluated.

Argentina

Argentine fishermen reported a catch of almost 0.4 million t in 1985, a 33 percent increase over the 0.3 million taken in 1984. Argentina has one of the world's largest underutilized fisheries resource. The country's fishing industry, however, continues to have severe problems. The Government had hoped to achieve a catch of 1.0 million t, or more, by 1980, an amount that could easily be supported by offshore resources.

The economic problems experienced by the major fishing companies and their mounting debts have forced many companies to restrict their fishing effort. These problems have kept the annual catch below 0.5 million t throughout the 1980's. The Government's fisheries development program has also been complicated by continuing difficulties with the United Kingdom over the Falkland Islands. The British maintain a 150-mile Falklands Island Protection Zone, restricting both Argentine fishermen and Argentine efforts to limit foreign fishing in the area. Argentina could theoretically request British permission to fish off the Falklands, but as this would be considered de facto recognition of British jurisdiction, the Government has not done so. The British do not require other countries to request permission to fish off the Falklands. They have, however, contacted some of the countries active in this fishery to convince them of the need to limit their fishing effort.

Foreign fishing, which has expanded significantly since 1982, has been especially harmful to Argentina. Many countries fishing in the South Atlantic, especially Poland, market their catch on the international market, thus placing themselves in direct competition with Argentine companies. This competition has had an especially severe impact on Argentine squid exporters who report that the prices they received declined by about 30 percent during 1985. Other exporters were hurt by changes in the tariff regime of the Latin American Integration Association (ALADI). Most Argentine exporters, however benefited by the declining availability of cod on the U.S. market. This shortage of cod helped sales of Argentina's traditional fishery export—hake, a cod substitute.

Hake sales increased during 1985, despite increased competition from South Africa. Shipments totaled $147 million, an 8 percent increase over the $136 million exported in 1984. The increased hake sales have aided many hard-pressed Argentine companies. Several countries were reportedly close to bankruptcy because of previous debts and an unexpected decline in shrimp catches which began in mid-1985. Many companies had become dependent on the shrimp fishery which they developed along the central coast since 1982. Shrimp was the country's principal fishery export commodity in 1984 thus making the precipitous drop in shrimp catches in mid-1985 that much more devastating.

Some fishermen reported improved shrimp landings in early 1986, but officials remain uncertain about the future of this fishery. The outlook for the country's entire fishing industry also continues to be unclear. Many factors cloud the industry's future: low international prices for many Argentine species, high interest rates, government regulations and economic policy, high domestic costs, and the decline of shrimp stocks. (Source: IFR-86/32.)

Japan, France Sign Fisheries Agreement

Japanese and French Government representatives met in Tokyo in June and agreed to extend operations by Japanese tuna fishing vessels in the Exclusive Economic Zones (EEZ) of France's territories in the South Pacific. The agreement will be in effect until 19 August 1987 and will permit Japan to fish off New Caledonia, French Polynesia, and Wallis and Futuna Islands. These areas serve as complementary fishing grounds for the Japanese tuna fleet, which passes through them on the way to more important fishing grounds off New Zealand and South America.

The Japanese-French fisheries agreement has traditionally included Japanese fishing operations off French territories in the Indian Ocean and off western Central America, as well as the South Pacific. Japan has fished in these areas intermittently since the 1979-80 agreement (Table 1). The Japanese agreed to end fishing operations off French islands near Madagascar in the 1986 agreement, primarily because very few vessels actually operated there in 1985. However, Japan will resume trial fishing

operations around Clipperton Island off the west coast of Central America.

The Japanese-French agreement has been renewed annually since it was first signed in 1979. France has been steadily increasing Japan's catch quotas since the 1983-84 season (Table 1) in exchange for more Japanese technical and development assistance to its territories. The fishing fees agreed on by the Japanese have also increased accordingly, from $211,000 in 1983 to $645,000 in 1986. (Exchange rates used for 1983 and 1986 were approximately 8.3 FF/$ and 7.3 FF/$ (30 June 1986), respectively.)

The four main provisions of the current agreement are:

1) Number of vessels: The total number of Japanese vessels permitted to fish in French overseas territorial waters was increased from the 1985 quota of 140 vessels to 153.

2) Catch quota: The 1986-87 catch quota is 9,124 metrics tons (t) of fish (primarily tuna), up nearly 20 percent from the 1985-86 quota of 7,650 t.

3) Fishing fees: Total fishing fees for the 1986-87 agreement are $645,000. French Polynesia will receive the largest portion of these fees—about $485,000. New Caledonia and Wallis and Futuna Islands will receive $129,000 and $30,000, respectively. Japan will continue to pay the fishing fees in a lump sum to the individual territories. Since the sixth extension of the agreement (1984-85), the Japanese have been trying to change the present system of lump sum payments to a per-vessel basis. Japan has consistenly not used its entire quotas for both catch and number of vessels, resulting in a high cost per vessel for those fishermen participating in the fishery. For example, only 28 Japanese fishing vessels operated in the French South Pacific territories out of a total vessel quota of 107 in the 1983-84 season. The catch was only 762 t, 16 percent of the total 4,660 t quota. The 1985-86 catch amounted to 1,150 t, only 15 percent of the total 7,650 t quota. This means that the Japanese paid fees of about $334 per ton of fish compared to $50 per ton if they had caught their entire quota.

4) Fisheries cooperation: In addition to fishing fees, the Japanese have agreed to provide fisheries assistance to each of the French South Pacific territories. They will send two fisheries experts and two fishery training vessels to French Polynesia to train local fisheries technicians at a cost of over $600,000. Of this total, about $485,000 will be paid in fishery fees and the remainder will be paid in materials and equipment. New Caledonia and Wallis and Futuna will be given fishery equipment worth $13,000 and $6,500, respectively. Japan has been providing materials and equipment for development of all three territories' coastal fisheries since the 1983-84 agreement. In the 1984-85 agreement, Japan agreed to conduct some exploratory fishing off New Caledonia and French Polynesia, provide French Polynesia with a small research vessel, and train two technicians. In addition, the Japanese agreed to send experts to study the development potential of French Polynesia's local fishing industry. (Details of Japanese fisheries aid to the French South Pacific territories in the 1985-86 agreement were not available.) (Source: IFR-86/49.)

Table 1.—Japan's fisheries agreements with France; agreement provisions by duration, fishing grounds, fees, number and type of vessel, and catch quota, 1981-87.

Duration	Fishing grounds	Fishing fees[1] (1,000 FF)	No. of Vessels and type[2]			Catch quota (t)
			Longline	Pole-and-line	Total	
20 July 1979-	New Caledonia	506	N/A	N/A	70	3,375
19 July 1980	French Polynesia	1,013	N/A	N/A	255	3,750
	Wallis and Futuna	330	N/A	N/A	40	1,500
	Tromelin[3]	45	N/A	N/A	15	225
	Clipperton	None	N/A	N/A	35	Unlimited
	Total	1,894	N/A	N/A	415	8,850
July 1980- Aug. 1981	N/A	N/A	N/A	N/A	N/A	N/A
Aug. 1981-	New Caledonia	N/A	N/A	N/A	105	5,800
Aug. 1982	French Polynesia	N/A	N/A	N/A	290	5,600
	Wallis and Futuna	N/A	N/A	N/A	60	1,400
	Tromelin[4]	N/A	N/A	N/A	35	100
	Total	3,248	N/A	N/A	490	12,900
19 Aug. 1982-	New Caledonia	N/A	N/A	N/A	105	5,550
18 Aug. 1983	French Polynesia[3]	N/A	N/A	N/A	136	3,600
	Wallis and Futuna	N/A	N/A	N/A	60	1,350
	Tromelin[4]	N/A	N/A	N/A	10	200
	Total	2,865	N/A	N/A	311	10,700
19 Aug. 1983-	New Caledonia	N/A	N/A	N/A	N/A	N/A
18 Aug. 1984	French Polynesia	N/A	N/A	N/A	N/A	N/A
	Total	1,760	78	29	107	4,659
19 Aug. 1984-	New Caledonia	658	24	5	29	2,350
18 Aug. 1985	French Polynesia	1,305	54	0	54	3,000
	Wallis and Futuna	162	0	7	7	540
	Clipperton	None	Unlimited	Unlimited	Unlimited	Unlimited
	Total	1,855	78	12	90	5,890
20 Aug. 1985-	New Caledonia	822	25	11	36	2,650
19 Aug. 1986	French Polynesia	2,100	94	10	104	5,000
	Total	2,922	119	21	140	7,650
20 Aug. 1986-	New Caledonia	943	31	6	34	2,645
19 Aug. 1987	French Polynesia	3,543	113	0	113[5]	5,900
	Wallis and Futuna	220	0	6	6	579
	Clipperton	None	Unlimited	Unlimited	Unlimited	N/A
	Total	4,706	144	12	153	9,124

[1]Fees are paid in French francs (FF). Approximate annual franc/dollar exchange rates for 1979-1985 are: 1979 = 4.3 FF/$, 1981 = 5.7 FF/$, 1982 = 6.7 FF/$, 1983 = 8.3 FF/$, 1984 = 9.5 FF/$, and 1985 = 7.6 FF/$. The exchange rate at the signing of the 1986 agreement was approximately 7.3 FF/$ (30 June 1986).
[2]N/A = Not available.
[3]Agreement period was to end on April 19. Extension beyond that date was conditional on satisfactory compliance of the agreement terms by Japan.
[4]Also includes Glorieuses, Juan-de-Nova, and Europa at Bassas-da-India islands.
[5]The number of vessels is not to exceed 30 at any one time.

Major Japanese Tuna Firms Alter Operations

Japanese fishing companies became major earners of foreign exchange after World War II, exporting mainly to the United States and Europe. Currently, however, because of growing competition from developing countries (particularly Taiwan and the Republic of Korea), as well as the enforcement of 200-mile Exclusive Economic Zones, Japanese companies are now changing the way they do business throughout the fishing industry, especially their tuna operations. Five important Japanese companies[1] (Taiyo, Nippon Suisan, Nichiro, Kyokuyo, and Nichirei) are taking several measures to adjust their tuna and other operations to the changing conditions. They are buying more fish from foreign vessels, moving processing plants overseas, and increasing the share of processed and semiprocessed fish in their overall trade; in the past, they tended to catch their own, or buy whole fish, and process the fish themselves.

Taiyo Fishing Company

Taiyo is the largest marine products company in Japan, handling all facets of the seafood industry from catching to selling. Taiyo began its operations before World War II, exporting tuna to the United States. After the war, it extended its tuna fishing operations to the Atlantic Ocean, processing it aboard factory ships, and selling it directly to Europe. At the same time, Taiyo started trading in other fisheries products, greatly increasing its exports. Taiyo has been airshipping bluefin tuna from Boston to Japan since 1971, and is currently importing and marketing about 200 individual bluefin tuna annually. Taiyo is heavily involved in overseas operations, and has 21 overseas subsidiaries and affiliates, 3 of which are engaged in tuna. It also hopes to expand its already impressive cooperative fishing operations.

Taiyo's tuna operations are quite diverse. It is involved in cooperative fishing with domestic fishermen, a joint venture (J/V) in the Solomon Islands, and tuna aquaculture in the Mediterranean Sea. Taiyo is actively engaged in fishing operations with a number of other Japaneses companies. Taiyo's tuna longlining cooperative operations consist of six of its own vessels, four from Hakodate Public Fishing Corporation, three from a subsidiary of the Hokkaido Fishing Corporation, three from Daito Deepwater Fishing, and one from Goyo Suisan, for a total of 17 vessels. Its tuna purse seining cooperative operations consist of three Taiyo vessels and one each from Taisei Fisheries and Goyo Suisan, totalling five vessels.

A Taiyo subsidiary has cultured tuna in Ceuta, a Spanish island in the Mediterranean, since 1973. In 1985, it harvested 610 fish. Tuna eggs are obtained from a local fishermen's union, and are hatched and grown to about 20 kg before harvesting. The head, tail, fins, and internal organs are removed and the fish are packed in ice, then shipped to Madrid. From there they are airshipped to Narita airport, outside of Tokyo. Harvesting takes place between July and December. Taiyo stations five to six technicians in Ceuta.

Taiyo has a joint venture (J/V) with the Government of the Solomon Islands to catch, process, and export canned and processed fishery products and engage in bonito longlining. The J/V was set up in 1973 for a 10-year period. The agreement was extended in November 1981 and will be in effect through 31 December 1992. The J/V company, Solomon-Taiyo, previously sold frozen tuna and bonito to U.S. packers in Guam and Puerto Rico, but because market conditions have changed significantly, its primary frozen tuna market is now Thailand, where canners have greatly expanded production. Low prices for the J/V's products have made this operation only marginally profitable to manage. However, as it is critical to the Solomon's economy, accounting for about 40 percent of the Island's total foreign currency earnings, it is unlikely to halt operations. The company also exports tuna and bonito packed in oil to the European Community. The company's fleet consists of 34 pole-and-line vessels, one small purse seining vessel, and two transport vessels. The operation catches approximately 10,000 metric tons (t) of bonito and tuna per year; its canneries produce approximately 100,000 cases of tuna per year. Solomon-Taiyo's plans for a new cannery, however, have been shelved due to the current low tuna prices.

The company has directed much of its recent efforts in building new vessels and adjusting marketing patterns to new conditions. Taiyo is investing in all-weather fishing vessels which can operate in extreme northern latitudes and produce high-quality products at the same time. Taiyo has recently taken steps to introduce the latest technology on its new vessels to cut costs. (Older vessels are being replaced with new additions to improve production efficiency. The company has replaced 10 of the 17 cooperative vessels so far in 1986.)

Taiyo is slowly strengthening its domestic marketing, buying fresh and frozen fish from Taiwan and the Republic of Korea (ROK) for processing and subsequently reexporting it, reorganizing its sales network for tuna and bonito, and broadening its middleman operations. Because of the breakup of Azuma Suisan, a Taiyo subsidiary established in 1978 to handle domestic and international tuna trade, Taiyo plans to create a centralized marketing and administrative body within the company and thus improve sales. This centralized body will be in charge of all Taiyo's tuna operations. Taiyo's tuna supplies come from three main sources: The catch from its cooperative fishing operations (30 percent), domestic purchases (30 percent), and imports (30 percent),

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Note: Unless otherwise credited, material in this section is from either the Foreign Fishery Information Releases (FFIR) compiled by Sunee C. Sonu, Foreign Reporting Branch, Fishery Development Division, Southwest Region, National Marine Fisheries Service, NOAA, Terminal Island, CA 90731, or the International Fishery Releases (IFR), Language Services Biweekly (LSB) reports, or Language Services News Briefs (LSNB) produced by the Office of International Fisheries Affairs, National Marine Fisheries Service, NOAA, Washington, DC 20235.

mainly from Taiwan and ROK. The remaining 10 percent comes from trade in processed tuna, an area which Taiyo is hoping to greatly expand. Taiyo now handles about 12,000-13,000 t of processd tuna annually, worth about $130 million (at ¥154 = US$1).

Nissui Company (Nippon Suisan)

Nissui was a small company engaged in tuna trolling prior to World War II. After the war, Nissui began tuna factoryship operations and processed tuna jointly with Hokoku Suisan. Hokoku, however, wanted to emphasize land-based operations, while Nissui wanted to continue its factoryship operations. The two companies formally split up in 1969 when Hokoku decided to restructure its management.

Nissui operations were centered on whaling and salmon fishing after the split. Seven years later, in 1976, Nissui decided to return to tuna marketing. Because of its long absence from this business, Nissui had to rebuild its sales network from the ground up. Its sales have steadily expanded since, and are expected to reach $143 million in 1986, compared to zero 10 years ago. This growth reflects the considerable influence Nissui has in Japan's tuna industry.

Initial 1986 sales projections were over $160 million, but because the price of tuna decreased 30 percent in 1985, revenue decreased despite an increase in the quantity sold. At present, Nissui is selling its products mainly to fish retailers and large wholesalers. It also has several processing plants in Shizuoka Prefecture, and one in Tokyo. Nissui's main species is now bigeye tuna. Nissui is planning to develop new distribution channels for all its products, including tuna. It hopes to expand sales through high-volume chain stores and plans to concentrate its operations on low-fat fish, expanding the number of species handled.

Nichiro Fishing Company

Nichiro was unable to conduct its traditional North Pacific fishing operations during World War II, but rebuilt its bottom-fishing operations following the war. It steadily increased its fleet and began tuna purse seining off the coast of Africa. After the "tuna mercury" scare and the 1973 oil crisis, Nichiro restructured and eliminated its tuna fishing operations. (In early 1973, there were reports that tuna were found with hazardous levels of mercury in their systems, causing a drastic decrease in consumption of tuna in Japan. This blow was followed in late 1973 by the substantial increase in oil prices.)

While the company eliminated its own fishing operations in 1973, it is still engaged in the tuna business, importing bluefin from North America and purchasing the catch from subsidiaries in Latin America. Since 1972, Nichiro has been airshipping bluefin tuna from Canada and Boston to Japan in cooperation with Marubeni, a large Japanese trading company. Each company handles 400 individual bluefin per year, for a total of 800, representing 40 percent of Japan's bluefin tuna imports from this area. Both companies expect bluefin prices to keep rising, and hope to further expand their business.

Nichiro has a subsidiary in Ghana which operates four pole-and-line fishing vessels and one purse seiner; all five fish for skipjack tuna. It is also fishing for skipjack tuna off Brazil in cooperation with a local fishing company. Nichiro presently does not plan to enter any new markets, but does hope to expand its tuna airshipping operations.

Kyokuyo Company

Kyokuyo was the first large Japanese fishing company to enter the tuna industry. Following World War II, it began tuna longlining with four vessels. It discontinued this fishery in 1970 after a management shakeup and began to concentrate on tuna sashimi sales. In 1973, Kyokuyo began operations with a refrigeration company to produce primarily high- and medium-grade tuna. This was the beginning of the company's vertical integration. Kyokuyo later purchased a freezing and processing plant jointly with the same refrigeration company. Following the consolidation of Japan's whaling industry, Kyokuyo purchased three purse seiners and resumed tuna fishing operations.

Kyokuyo is currently operating its three vessels jointly with a vessel from Daido Suisan. It replaced one of its older vessels with a newly constructed one in May 1986. Kyokuyo has yearly sales of $195-227 million, making it one of Japan's largest fishing companies. It is involved in both wholesale and retail fish sales and its offices in Tokyo and Osaka have special tuna sales sections. Kyokuyo hopes to increase tuna sales through high-volume retail chains by emphasizing the wholesale and retail sectors.

Nichirei Company

After World War II, Nichirei was a major exporter of frozen tuna to the U.S. with operations in Samoa. In 1963, it moved all of its offshore operations to St. Martin (Netherlands Antilles) in the Caribbean. Nichirei built all of its own roads and piers, and acquired a refrigerated transport vessel. It later built two additional cold-storage facilities and its business began to expand rapidly. Nichirei was one of the first Japanese fishing companies to move its operations overseas.

Nichirei stations 10 employees in St. Martin and services approximately 40-45 Taiwanese longliners (250-300 GRT) which land about 12,000-13,000 t of fish annually. The tuna, which is about 80 percent of the catch, is transshipped to Puerto Rico where it is processed in one of five canneries. (The Nicholson Act (Title 46 U.S.C. 251 A) prohibits foreign fishing vessels from landing fish directly at U.S. ports. To comply with the Nicholson Act, the Taiwanese fishing vessels have to first land the fish in St. Martin (Netherlands) and then Nichirei transships to canneries in Puerto Rico.) About 1,000 t of the remainder of the catch, mainly striped marlin, blue marlin, and bigeye tuna, is exported to Japan. The rest is sold locally. Curacao Pioneering, a locally incorporated company, operates the St. Martin facility. In addition to purchasing the catch from Taiwanese vessels in St. Martin, Nichirei also purchases fish from Las Palmas (Canary Islands, Spain), Montevideo (Uruguay), and Capetown (South Africa). Nichirei plans to expand its current operations, which are already mostly overseas. (Source: IFR-86/43.)

New NMFS Scientific Reports Published

Some publications listed below may be sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Copies of all are sold by the National Technical Information Service, Springfield, VA 22151. Writing to either agency prior to ordering is advisable to determine availability and price (prices may change and prepayment is required).

NOAA Technical Report NMFS 39.

Swan, George A., Tommy G. Withrow, and Donn L. Park. **"Survey of fish protective facilities at water withdrawal sites on the Snake and Columbia Rivers."** April 1986, iii + 34 p., 26 figs., 6 tables, 1 appendix.

ABSTRACT

Proliferation of water withdrawals and new pump intake and screen designs has occurred with the growth of irrigated agriculture along the Columbia and Snake Rivers. Concern for the protection of anadromous and resident fish populations resulted in formulation of a survey of the water withdrawal systems. The survey included distribution studies of juvenile fish near pump sites and field inspection of those sites to determine adequacy of screening for protection of fish. A total of 225 sites were inspected in 1979 and 1980, with a follow-up inspection of 95 sites in 1982. Results indicated a definite trend toward lack of concern for the condition of fish protective facilities. Only 4 out of 22 sites not meeting criteria in 1979 had been upgraded to acceptable conditions. Of more concern, 13 of the sites meeting criteria in 1979 were below criteria when reinspected in 1982. Some of the discrepancies included lack of protective screens, poorly maintained screens, and screens permitting excessive velocity that could result in impingement of larvae or small fish. A conclusion from these surveys is that if adequate protection for fish is to exist, screens for water withdrawals need to be properly installed, inspected, and maintained.

NOAA Technical Report NMFS 40.

Fisheries Management and Large Marine Ecosystems

Large Marine Ecosystems (LME's) are extensive areas whose fishery resources are linked via continuity and similarity of the region's bottom configuration, oceanic currents, temperature ranges, and other specific environmental and biological conditions, and scientists have been moving toward management of such ecosystems slowly for many years. Those close to land masses are beset by increased stress from pollution, as well as exploitation which must be measured and accounted for in management schemes.

Marine fisheries studies have progressed from single species and their yields to a more holistic approach, focussing on entire ecosystems and the multispecies assemblages and interactions which influence annual production of fisheries. Thus, **"Variability and Management of Large Marine Ecosystems"**, edited by Kenneth Sherman and Lewis M. Alexander is a timely review of the state-of-the-art in measuring changes in fish populations and productivity in LME's, LME physical-chemical environments, and management options available to governmental agencies for the LME's.

The volume represents the first symposium on the "Variability and Management of Large Marine Ecosystems" which was convened at the 1984 Annual Meeting of the American Association for the Advancement of Science. It was published as AAAS Selected Symposium 99 by Westview Press, 5500 Central Avenue, Boulder, CO 80301.

The contents are presented in three parts, with part one contributions examining the impact of perturbations on the productivity of renewable resources in large marine ecosystems. Part two contains articles on ways of measuring variability in large marine ecosystems, and part three contributions discuss the institutional frameworks—political, economic, legal, etc.—for managing LME's.

In sum, the authors and editors have done a fine job in drawing together and synthesizing current knowledge on LME problems, resources, and resource management, and the book should be of value to a wide range of marine students, scientists, and resource managers. Indexed, the 319-page paperbound volume is available for $31.95.

A Guide for Prospective Salmon Shark Fishermen

Publication of the **"Salmon Shark Manual,"** by Brian Paust and Ronald Smith and edited by T. Frady, has been announced by the Alaska Sea Grant College Program, 590 University Avenue, Suite 102, Fairbanks, AK 99709-1046. It is subtitled "The development of a commercial salmon shark, *Lamna ditropis*, fishery in the North Pacific," but it includes reviews of shark fishing gears and techniques, shark preservation and marketing, shark food products and by-products, and much more. In trying to target a select group of Alaskan fishermen, processors, and managers deemed "early adopters" of new technology or fishing strategies, the authors have provided extensive and very detailed information that will be useful to anyone interested in the development of shark fisheries far outside Alaska.

The authors begin with a review of the Southeast Alaska Salmon Shark Project (SEASP), which stimulated the volume, discuss the edibility of sharks, review the sharks and skates found in Alaskan waters (and taxonomy of Alaskan sharks). Then they comprehensively

Myers, Edward A., Donald E. Hoss, Walter M. Matsumoto, David S. Peters, Michael P. Seki, Richard N. Uchida, John D. Ditmars, and Robert A. Paddock. **"The potential impact of Ocean Thermal Energy Conversion (OTEC) on fisheries."** June 1986, iii + 33 p., 11 figs., 8 tables.

ABSTRACT

The commercial development of ocean thermal energy conversion (OTEC) operations will involve some environmental perturbations for which there is no precedent experience. The pumping of very large volumes of warm surface water and cold deep water and its subsequent discharge will result in the impingement, entrainment, and redistribution of biota. Additional stresses to biota will be caused by biocide usage and temperature depressions. However, the artificial upwelling of nutrients associated with the pumping of cold deep water, and the artificial reef created by an OTEC plant may have positive effects on the local environment.

Although more detailed information is needed to assess the net effect of an OTEC operation on fisheries, certain assumptions and calculations are made supporting the conclusion that the potential risk to fisheries is not significant enough to deter the early development of OTEC. It will be necessary to monitor a commercial-scale plant in order to remove many of the remaining uncertainties.

NOAA Technical Report NMFS 41. Bohnsack, James A., and Scott P. Bannerot. **"A stationary visual census technique for quantitatively assessing community structure of coral reef fishes."** July 1986, iii + 15 p., 13 figs., 3 tables.

ABSTRACT

A new method is described and evaluated for visually sampling reef fish community structure in environments with highly diverse and abundant reef fish populations. The method is based on censuses of reef fishes taken within a cylinder of 7.5 m radius by a diver at randomly selected, stationary points. The method provides quantitative data on frequency of occurrence, fish length, abundance, and community composition, and is simple, fast, objective, and repeatable. Species are accumulated rapidly for listing purposes, and large numbers of samples are easily obtained for statistical treatment. The method provides an alternative to traditional visual sampling methods. Observations showed that there were no significant differences in total numbers of species or individuals censused when visibility ranged between 8 and 30 m. The reefs and habitats sampled were significant sources of variation in number of species and individuals censused, but the diver was not a significant influence. Community similarity indices were influenced significantly by the specific sampling site and the reef sampled, but were not significantly affected by the habitat or diver.

review the salmon shark's distribution, feeding behavior, and prey relationships. Also reviewed is the functional biology and the physiology of lamnid sharks, shark reproduction strategies and growth, salmon shark research and harvest in Japan, and problems of elasmobranch fisheries management.

Following a lengthy review of North American and European shark fishing methods and gear, the authors discuss development of a sport fishery for salmon shark in Alaska, list commercial shark fishing strategies applicable to the species, and review contemporary shark food products and commercial byproducts. Then follow reviews of the characteristics and preparation of shark meat, shark quality control standards for harvesters and processors, methods for handling shark on small fishing vessels, processing and marketing of shark fins, hides, jaw sets, and teeth, and processing and marketing shark byproducts (i.e., blood serum, cartilage, livers, etc.). Also discussed at length is the economic background of various world shark fisheries with reference to development of salmon shark fisheries of the North Pacific.

Several appendices then review initial processing of shark fins, potential purchasers of trimmed shark fins, future research opportunities involving development of salmon shark fisheries, a potential fishery for the mud shark, *Hexanchus griseus*, in southeastern Alaska, and potential purchasers of shark meat, oils, hides, and other byproducts.

All in all, the volume is a very comprehensive review of the literature and information on the salmon shark, shark fishing techniques, and the utilization, handling, and marketing of sharks. Paperbound, the large-format 430-page volume, report AK-SG-86-01, is available from the publisher for $9.00.

A Useful Guidebook to West Coast Marine Life

If the value of a book can be gauged by the number of editions printed, then **"Between Pacific Tides"** by Edward F. Ricketts, Jack Calvin, and Joel W. Hedgpeth, with the fifth edition revised by David W. Phillips, is a classic. The original edition was written in 1939, and the volume has become an excellent reference for U.S. Pacific coast students and professionals alike. In short, this newly revised volume reviews the animals and habitats of the bays, estuaries, rocky shores, and tidal pools of the U.S. Pacific Coast. It is particularly well written and also is very well illustrated with many photographs and drawings, all in black and white. The species are all grouped according to their most characteristic habitat (i.e., rocky shore, sandy beach, eelgrass flat, mud flat, wharf piling, etc.), and the species' life history, physiology, and interrelationships are discussed.

Besides those chapters, others review intertidal zonation, principles of intertidal ecology, and an extensive section of reference matter is presented, including an outline of the major taxa, an annotated systematic index, a general bibliography, and a general index. This latest edition has been enlarged about 20 percent, with many changes and additions, and the systematic index and bibliography has been greatly updated and expanded (almost 2,300 entries). It also includes the interesting Prefaces to the earlier editions, as well as John Steinbeck's Foreword to the 1948 edition.

The references are unique in that the

general bibliography is divided into four areas: 1) essential general references related to seashore life, 2) other useful texts and general references, 3) selected papers on marine ecology and related topics, and 4) books and papers on geology, paleontology, and zoogeography. Other references dealing primarily with specific animals or groups are listed in the Annotated Systematic Index. Most of the works listed were published after 1967.

The 652-page hardbound volume is an excellent reference to a rich and diverse coastal region and is available from the Stanford University Press, Stanford, CA 94305 for $29.50.

An International Marine Reference Guide

"Maritime Affairs—A World Handbook," subtitled "A reference guide to maritime organizations, conventions and disputes and to the international politics of the sea" has been published by Longman Group Limited, Longman House, Burnt Mill, Harlow, Essex, U.K. CM20 2JE, and is distributed in the United States by Gale Research Co., Book Tower, Detroit, MI 48226.

As the title and subtitle imply, the volume is a wide ranging reference to marine-related laws, transportation, resources, communications, scientific research, boundary disputes, and military matters. Several chapters are of interest to those involved with marine living resources.

Chapter 1 provides data on the Law of the Sea—historical development of maritime law, UN conferences and Conventions on the LOS, and territorial claims by coastal states. Chapters 2 and 3 (international organizations and shipping) have little data on fisheries. However, Chapter 4 presents data (for 1983) on fish harvests and trade, coastal state EEZ claims, descriptions of major conventions and agreements, national legislation on fisheries, and a listing of international organizations concerned with marine resources. Chapter 5, "Environmental and Scientific Interest in the Sea," provides data on dimensions of the marine pollution problems; conventions, agreements, and legislation on marine pollution; aspects of scientific research related to the sea; and international bodies involved in ocean research. Chapter 6 is on maritime boundary disputes and Chapter 7 is on military uses of the sea. Also published is the full text of the UN Convention of the Law of the Sea, as well as an extensive listing of maritime journals. Indexed, the hardbound 412-page volume is available for $90.00 from Gale Research Co.

Research, Management, and Life History of the Dungeness Crab

Number three in the University of Alaska's Lowell Wakefield Fisheries Symposia Series is **"Proceedings of the Symposium on Dungeness Crab Biology and Management,"** B. R. Melteff, Symposium Coordinator. It was published as Alaska Sea Grant Report 85-3 by the Alaska Sea Grant College Program, University of Alaska, Fairbanks, AK 99701.

The symposium and volume were divided into five sessions, with Session I presenting reviews of the Dungeness crab fisheries of California, Oregon, Washington, British Columbia, and several areas of coastal Alaska. Session II on life history includes papers on the ecology, growth, and population dynamics of juvenile Dungeness crabs in Grays Harbor, Wash.; sampling design and methodology for juvenile Dungeness crab surveys; the role of estuaries in the crab's early life history; young-of-the-year abundance and growth in the nearshore environment; age and growth of male Dungeness crabs in northern California; and molt increments, annual molting probabilities, fecundity, and survival rates of adult female crabs in northern California.

Session III on mortality presents a review of Dungeness crab diseases, a paper on Dungeness crab predation by sea otters in Prince William Sound, and two studies on problems of Dungeness crabs exposed to bark debris at marine log transfer facilities. Session IV includes four papers on Dungeness crab population dynamics, and Session V includes five contributions including biases in crab tag recovery data, oceanography of Cook Inlet in relation to crab distribution, a review of the effects of Sevin on crab, oyster, and other estuarine species; and a review of crab feeding behavior—a review of the general evolutionary and ecological factors which characterize crabs of the genus *Cancer*, then placing the eight species studied into two major feeding or life-history specialization groupings and exploring the implications of this for management of the species and suggest management implications.

The Dungeness crab, *Cancer magister*, is fished commercially from mid-California to Alaska. But while the Alaskan fishery has grown in recent years, the more southerly fisheries have declined. Thus, this symposium presents a fine review of the species' biology, management, and population dynamics, and discusses management issues especially applicable to Alaska.

Manual for Research and Conservation of Marine Turtles

The second edition of the **"Manual of Sea Turtle Research and Conservation Techniques"**, edited by Karen A. Bjorndal and George H. Balazs has been published and is distributed by the Center for Environmental Education, 624 9th Street, N.W., Room 500, Washington, DC 20001. The manual was prepared for the 1983 Western Atlantic Turtle Symposium (WATS), sponsored by IOCARIBE, and its authors include Peter C. H. Pritchard, Peter H. Bacon, Fredrick H. Berry, Archie F. Carr, John Fletemeyer, Robert M. Gallagher, Sally R. Hopkins, Robert R. Lankford, Rene Marquez M., Larry H. Ogren, William G. Pringle, Jr., Henry A. Reichart, and Ross Witham.

The manual, in either English or Spanish, was prepared to aid in planning and research for the WATS 1982 and 1983 field research programs. The tech-

niques presented are considered "recommended" or "preferred", but are followed, where appropriate, by "alternatives", along with draft outlines of successful sea turtle survey data recording forms. The manual covers the six sea turtle species of the western Atlantic as well as the flatback turtle of Australia and Papua New Guinea and the black turtle of the eastern Pacific.

Requirements for a sea turtle conservation program, are given, followed by a lengthy section on survey techniques, which includes an identification guide to species, aerial and ground truth beach surveys, survey charts, pelagic and other aerial surveys, vessel surveys, nesting beach surveys, market surveys, turtle measurement and tagging, determination of hatching success, and more.

The section on management and conservation covers beach and nest protection from wild, domestic, and human predators; protection of turtles from beach erosion and later nesting turtles; egg handling and relocation, and release of hatchlings. Also covered is the incidental catch of turtles and its avoidance and the resuscitation of apparently drowned turtles. Data is given on protective legislation and enforcement, as well as on care of sea turtles in captivity—culture requirements and techniques for conservation or population restoration. Also included is a glossary of terms, extensive list of references, and an appendix of 40 color plates of the various species (at different ages) and their color variations. The 126-page paperbound volume is a fine manual for sea turtle researchers and costs $10.00.

Also distributed by the Center for Environmental Education are volumes 1-3 of the **"Proceedings of the First Western Atlantic Turtle Symposium,"** edited by Peter Bacon, Fred Berry, Karen Bjorndal, Harold Hirth, and Larry Ogren. Following the inaugural addresses and a history of the WATS, six panel sessions present an overview of the biology of the six western Atlantic sea turtles: the green, loggerhead, Kemp's ridley, olive ridley, hawksbill, and leatherback turtles. Additional panel sessions discuss research techniques and planning, habitat alteration impacts, utilization of turtles, their conservation, aquaculture, enforcement and regulations, status of the species, and management options. Another session dealt with future actions to conserve sea turtles, along with a symposium summarization. Also included are the first five appendices: A glossary of terms, abstracts of posters, an announcement of the manual of research and conservation techniques, list of registered participants, and a report on eastern Pacific sea turtle research.

Appendix 6 is volume 2, the **"Annotated Bibliography of Sea Turtle Research in the Western Atlantic,"** by Peter R. Bacon. This was compiled as a WATS background document and presents references (up to May 1983) to sea turtle research, populations, and socioeconomics. It totals 954 annotated citations from scientific journals (604), books (56), theses (12), newsletters (36), government reports (116), and miscellaneous sources (130), i.e., conference proceedings, manuscript reports, reports to international agencies, etc. References are relevant only to the Western Central Atlantic Region, excluding references to the southern parts of Brazil and the United States north of the Carolinas. *Chelonia mydas* has the most references (332), followed by *Caretta caretta* (254), *Dermochelys coriacea* (187), *Eretmochelys imbricata* (134), *Lepidochelys kempi* (124), and *Lepidochelys olivacea* (61). Most of the publications (624) were published between 1970 and 1973; less than 80 were published before 1940. Most of the geographical citations referenced U.S. research (260), trailed by Mexico (85), Costa Rica (66), Suriname (47), Cayman Islands (34), French Guiana (33), Nicaragua (31), Venezuela (31), and all other nations less than 30. The 318-page volume is paperbound; price not listed.

Appendix 7, or volume 3, contains **"The National Reports,"** edited by Peter Bacon, Fred Berry, Karen Bjorndal, Harold Hirth, Larry Ogren, and Michael Weber. Included are 40 reports for the WATS region's 38 nations; two reports were submitted by Mexico and Netherlands Antilles to facilitate subregional analyses. They are either official "National Reports," Draft National Reports, Ad Hoc Data Reports and some include a Supplemental Data Report. Report format, compiled by Harvey R. Bullis, Jr., presents tabular data on such items as geographic inventory, shoreline and bottom type habitat inventories, nesting beach inventory, nesting census, aerial beach survey, nesting female population assessments, foraging areas inventory and turtles present on foraging areas, nonforaging turtles at sea, natural mortality, various turtle harvest data, turtle culture operations, sanctuaries and refuges, national research projects, and more. The 514-page volume is paperbound; price not listed. Together, the volumes present an immense amount of data on the region's sea turtles, their biology, status, and management and outlook and will be a very useful reference.

Mooring and Anchoring and Marine Navigation

Publication of **"The Complete Book of Anchoring and Mooring"** by Earl Hinz has been announced by the Cornell Maritime Press, Inc., P.O. Box 456, Centreville, MD 21617. Basically, the author addresses anchoring systems and techniques and permanent moorings for all recreational and working vessels from 12 to 80 feet long.

The book is divided into three parts. Part I, "The Technology of Ground Tackle," employs a systems approach to determine loads at anchor and translate them into ground tackle design criteria. Topics include loads at anchor, deck gear for anchors, the anchor windlass, anchor rodes, anchor options, and anchor and rode selection.

Part II, "The Art of Anchoring," includes chapters on the human and safety factors in anchoring, techniques and tricks of anchoring, rights and responsibilities, and storm anchoring. And Part III, "The Mechanics of Anchoring," reviews permanent moorings, including mushroom anchor single point mooring, multiple anchor single point mooring, fore and aft buoyed and pile moorings, mooring maintenance, and rights to moorings. Indexed, the 309-page hardbound volume costs $22.50 and should be a useful reference for vessel users.

Also recently published by CMP is the 6th edition of **"How To Navigate Today"** by Leonard Gray, based on the original handbook by M. R. Hart. This handy pocket-sized guide to celestial navigation reviews in several concise chapters the basics of celestial navigation; star, sun, moon, and planet sights; the navigator's daily routine, other sight-reduction methods, sextant use, and use of the star finder. Also included is a list of references, a glossary, and excerpts from the "Nautical Almanac" and H.O. 249. The small 116-page handbook is paperbound, costs $5.50, and is a handy field guide for beginning navigators.

Far more comprehensive and aimed at advanced seafarers is CMP's **"Celestial for the Cruising Navigator"** by Merle B. Turner. This volume presents a comprehensive treatment of celestial navigation based upon the essential foundations of nautical astronomy and spherical trigonometry. The author begins with a discussion of position and time and proceeds systematically to show how sextant observations, coupled with time, provide indispensable checks and data on course, distance, and position. He emphasizes computational rather than tabular solutions to sight reduction problems and, while basic trigonometric fomulae are developed, all computation can be done with an inexpensive hand calculator. Two appendices provide some computational formulae and a glossary of terms. Indexed, the 222-page paperbound volume is available from CMP for $14.95.

Also recently published by CMP is the second edition of **"Star Sight Reduction Tables for 42 Stars"** by Thomas D. Davies, retired Rear Admiral of the U.S. Navy. It covers the years 1986-92, and the stars tabulated are of sufficient brightness to be readily sighted during evening or morning twilight. The tables cover lat. 60°N through 45°S. Thus, the user can shoot "stars of opportunity" when bad weather obscures some or many stars, eliminating the need for precomputation and the resultant frustration when cloud cover obscures the desired star. The author briefly explains how his method is to be used, provides examples of actual sights and a filled-in form showing how the work is done. The 440-page paperbound volume is available from the publisher for $28.50.

Crustacean Culture, Fisheries, Economics, Behavior, and Ecology

Volume 10 in the series "The Biology of Crustacea" is **"Economic Aspects: Fisheries and Culture,"** edited by Anthony J. Provenzano, Jr., and published by Academic Press, Inc., Orlando, FL 32887. The first three chapters provide broad reviews of the biology and exploitation of 1) shrimps and shrimp-like animals by Richard A. Neal and Robert C. Maris, 2) crabs by Paul A. Haefner, Jr., and 3) lobsters and crayfishes by J. Stanley Cobb and Denis Wang.

Data on the fisheries biology of shrimps are given for the penaeid and caridean shrimps and for stomatopod and zooplankton fisheries. For the major species in each group, information is given on their life cycles, habitat, population dynamics, behavior and migrations, ecological importance, and their management. Additional data covers fishing gears and methods, handling and preservation at sea and on shore, waste utilization, as well as perspectives on future demand and supply, fishery trends, new products, and research needs. The same general outline of information is provided for important species of crabs, lobsters, and crayfishes.

Provenzano then reviews in Chapter 4 the basics of crustacean culture—culture systems and their management, criteria for species cultured, seed supplies, and growout. In chapter 5 he provides more detailed information on the large-scale culture of shrimps and prawns, anomurans, crabs, and the lobsters and crayfishes. Each chapter provides extensive references and the volume is indexed by subject and taxonomic indexes. While single volumes have been devoted to individual species or fisheries, this book, in synthesizing data for many of the important crustaceans, was an ambitious project. Overall, it is a fine and useful review of and reference on an important segment of the world's fisheries. Hardbound, the 331-page volume is available from the publisher for $65.00 or £56.50.

Volume 7 in the same crustacean biology series is **"Behavior and Ecology,"** edited by F. John Vernberg and Winona B. Vernberg. The book is divided into six chapters in which various authors review information on 1) communication, 2) movement patterns and orientation, 3) biological timing, 4) symbiotic relationships, 5) pelagic larval ecology and development, and 6) biotic assemblages—populations and communities.

Both interspecific and intraspecific communication by crustaceans is dealt with by Michael Salmon and Gary W. Hyatt. They present an overview of communication in an ecological setting, as well as reviewing communication in terms of quantitative measurement, functions and mechanisms, and evolution, and suggest areas for future research. William F. Herrnkind then discusses orientation within various biotypes and over a long distance and patterns of movement of crustaceans in chapter 2.

In chapter 3, Patricia J. DeCoursey reviews the cyclic nature and timing of various crustacean biological functions, including matching of biological rhythms and environmental cycles and basic concepts of regulation of biological rhythms. She also surveys biological rhythms (organismic and cellular and physiological) in crustacea, and provides a perspective of the adaptive value of environmentally entrained clocks. D. M. Ross summarizes information on a variety of crustacean symbiotic relationships with both crustacean and noncrustacean hosts, and recommends additional research to analyze and better understand those relationships. A. N. Sastry then reviews work on larval ecology—how larval stages interact with the various biotic and abiotic factors in their environment, including egg incubation and hatching, larval development, adaptation to the environment, dispersal and recruitment, and the role of pelagic larvae in live histories. Finally Coull and Bell provide an overview of the complex interactions associated with biotic assemblages, using as examples three habitats where crustaceans are impor-

tant members (marine sandy bottom habitats, hard substrates—rocky shores and reefs, and marine and freshwater plankton assemblages). Each of the authors provides extensive references for their chapters and suggest fruitful areas for future research, and the volume provides a handy overview of crustacean behavior and ecology. The hardbound 338-page volume includes systematic and subject indexes and costs $51.50 or £43.00.

Ocean Variability and Salmon Production

"The Influence of Ocean Conditions on the Production of Salmonids in the North Pacific," edited by William G. Percy and published by the Oregon State University Sea Grant College Program in Corvallis, presents papers and comments on them from a workshop held just after the devastating 1982-83 El Niño when ocean catches of coho and chinook salmon off Oregon and Washington were lowest in recent history.

The first part of the workshop presents review papers on salmonid biology and oceanography, with each followed by a commentary providing often a somewhat different viewpoint or approach to the topic. Later, attendees broke into working groups on hatcheries, inlets and estuaries, the coastal ocean, and the open ocean. They identified problems and hypotheses that needed further research to improve our knowledge of the relationships between the ocean environment and salmonid stocks, and those reports are also contained in the publication.

Some of the the topics reviewed are: Factors associated with mortality of coho salmon from saltwater release facilities in Oregon, marine influences on the interannual variation in abundance of salmon, biology of juvenile coho salmon off Oregon and Washington, trends in abundance of northeast Pacific salmon stocks, oceanographic factors influencing the distribution, migration, and survival of salmonids in the northeast Pacific, and limitations on the ability to enhance Pacific salmon stocks.

Others include the variability of marine survival of Pacific salmon, interaction among sockeye salmon in the Gulf of Alaska, population dynamics of Bristol Bay sockeye salmon from 1956 to 1983, environmental factors and the abundance of Kodiak archipelago pink salmon, and more.

Overall, the workshop and publication presents a good review of the status of knowledge of the effects of the ocean environment on salmonid production in the northeast Pacific as of the early 1980's and should be a useful reference. (The publication is also a companion to a volume on nonsalmonid species entitled "From Year to Year: Interannual Variability of the Environment and Fisheries of the Gulf of Alaska and Bering Sea," edited by Warren S. Wooster and published by the University of Washington Sea Grant Program in Seattle.) Paperbound, the 327-page volume is available as Report ORESU-W-83-001 from Sea Grant Communications, Oregon State University, AdS A418, Corvallis, OR 97331 (price not listed).

Fish Oils and the Human Diet

"Omega-3, The Fish Oil Factors" by G. G. Pique has been published by Omega-3 Project, Inc., Suite 347, 10615-G Tierrasanta Blvd., San Diego, CA 92124. The author briefly reviews research into the role of fish oils and their omega-3 (n-3) fatty acids in the human diet in a somewhat popularized, yet still fairly technical, style of writing in an effort to promote greater use of omega-3-rich foods, particularly fatty fishes. Besides the effects on the cardiovascular system, the author also reports on perceived benefits of a fish-oriented diet for some who suffer from rheumatoid arthritis, phlebitis, colitis, and other inflammatory problems. And he questions the value of the widely used polyunsaturated vegetable oils in the diet.

Because the writing is partly technical and partly evangelical in tone, the book is difficult to categorize. References to "a true magic bullet" (EPA) and a "miracle food" (fish) may make some readers uncomfortable. Pique also discusses natural animal and vegetable sources of the omega-3 fatty acids and champions a diet based on one devised about 30 years ago by the late Averly Nelson, a Seattle, Wash., cardiovascular specialist who used a special fish-rich diet in the 1950's with heart patients and reported positive results. The author advises readers to consult with their physician and warns about the possibilities of vitamin toxicity in certain cases. A postprinting Appendix discusses the effects of omega-3 oils on atherosclerosis.

The small paperbound 163-page volume is available from the publisher for $9.95. Purchasers will also receive periodic updates (upon return of a coupon).

Hatching and Culturing the Rainbow Trout

An updated fourth edition of S. D. Sedgwick's 1973 **"Trout Farming Handbook"** has been published by Fishing News Books Ltd., 1 Long Garden Walk, Farnham, Surrey, England GU9 7HX. The original book has been much revised and additional chapters have been added. It includes a discussion of trout farming in floating cages in both freshwater and saltwater as well as treatment of trout farm effluent. Advice is also given on how to design and construct a modern trout farm, and data is included on the recognition and treatment of common trout diseases, trout hygiene, foods and feeding, egg sources and fry production, broodstock, trout processing and markets, profits, and prevention of losses. Well illustrated with photos and diagrams, the 160-page paperbound volume is available from the publisher for £10.00.

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